The Welding Engineer

Reg. U. S. Pat. Office

Founded by L. B. Mackenzie, 1916

DECEMBER, 1927 VOL. 12, No. 12

$3.00 per year in U. S. 608 S. Dearborn St., Chicago, Ill. $4.00 per year abroad

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The Welding Engineer

Founded by L. B. Mackenzie, 1916

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The Welding Engineer

wishes

its many thousands

of

loyal friends

a

Merry Christmas

and a

Prosperous New Year

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The Welding Engineer does not publish in its news or advertising columns any matter that deals with or refers to either personal or legal controversies.

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Readers of The Welding Engineer will find this index to contain the most accurate information obtainable relating to welding apparatus and supplies. The advertising section includes the principal manufacturers of the United States.

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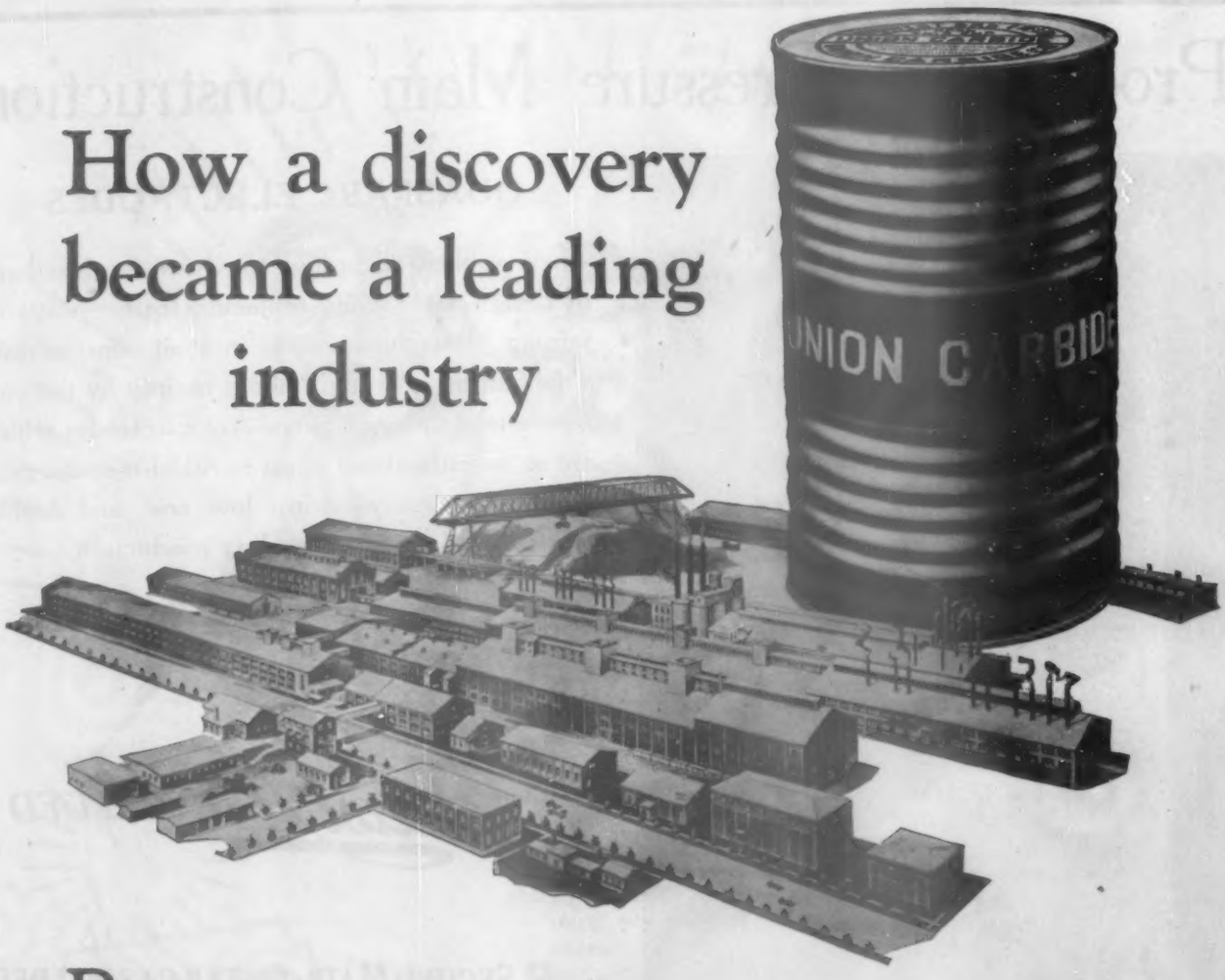
How a discovery became a leading industry



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←*A* FIRST MAIN: RIVETED

THIRD MAIN:
←*C* *Quasi-Arc*-WELDED

←*B* SECOND MAIN: WATER GAS WELDED

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Stainless Steel Electrodes Suitable for welding Stainless Steel.

QUASI-ARC INCORPORATED

Manufacturers of and Consultants in reference to the Application of Quasi-Arc Electrodes and Welding Equipments.

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Easy *and* Economical to Use *and* Dependable *in* Results

In these days of "quick service", it is important to know that your Welding Bronze is 100% RIGHT.

Mueller Improved Welding Bronze Rod is right as right can be. It is made only from pure, virgin metals, alloyed in electric furnaces. It is uniform in quality and free from impurities.

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Red Tip Brass Rod
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Mueller WELDING BRONZE ROD

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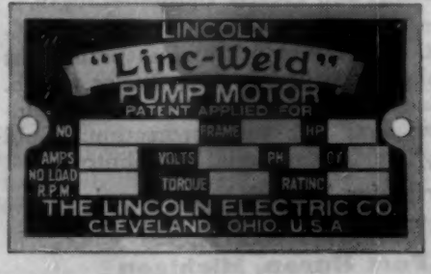
THREE GENERATIONS OF BRASS MAKING

Pop is color blind

"Here, Lad—

what's the matter with our welding foreman? Every time he gets a supply of the welding rod I buy for him . . . he sees red and explodes."



"No, Pop—

he sees BLUE.

He told me he had sent to the Lincoln people for a sample of their 'Stable-Arc', non-splashing BLUE welding rod.

Since trying it he has confided in me that the stuff you're buying for him, **he can't see at all.**

But he DOES see the BLUE rod . . . because he can see the freer flowing, faster handled weld he makes with it.

But if you continue to buy him that run-of-mill rod that slows up his production, it won't be the foreman who sees red . . . it will be the treasurer who will **put** us in the red."

The Lincoln Electric Co., Dept. No. 27-12, Cleveland, Ohio

W-25

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an enduring bronze
by Herman A. MacNeil.

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But the elements of nature do not wage more cruel warfare than a Natweld Gauge in service is subjected to. Again enduring bronze conquers. The specially treated bronze Bourdon Spring of a Natweld Gauge endures these stresses unflinchingly. Yet Natweld Gauges cost no more, for quantity demand has made possible a volume of production which brings you quality at low price.

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In absolute reliability of operation and over-all efficiency, G-E Arc Welders are unequalled. They are available in all sizes, all types—for either hand or automatic operation—for one or more operators.

550-21

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The Atomic Hydrogen Arc Welder
is now ready!

This remarkable welder will produce ductile welds.

It will produce smooth welds.

It will weld thin metals—as thin as .005 inches.

It is simply constructed, mechanically and electrically.

It is easy to operate.

It is now available for hand-welding operation from 60-cycle power supply.

Address all inquiries to your nearest G-E office.

Electrode holder for atomic hydrogen arc welding

530-35

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No matter what kind of welding you do--

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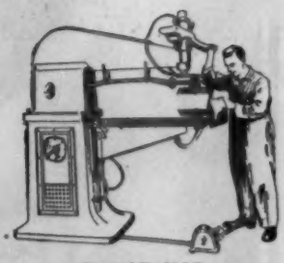

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REPAIR

If you Weld, you need this book

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Fifth Edition

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Contents

1. Illustrated encyclopedia covering all words, terms, and trade names used in welding.

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ARC WELDER

A new development in Electric Welding that Combines D. C. ARC Advantages with the Merits of the A. C. ARC

An Entirely New Welding Principle Found Exclusively in the Owen Welder

Furnished with complete equipment as illustrated, ready to install and operate.

Approved and accepted by National Board of Fire Underwriters' Ass'n

Exhaustive tests and experience of enthusiastic users prove the OWEN INDUCTION WELDER supreme as the only welder embodying all essential and desirable features of other type machines.

The OWEN soon pays for itself in profits and savings. Can be purchased on attractive terms

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Advanced Design
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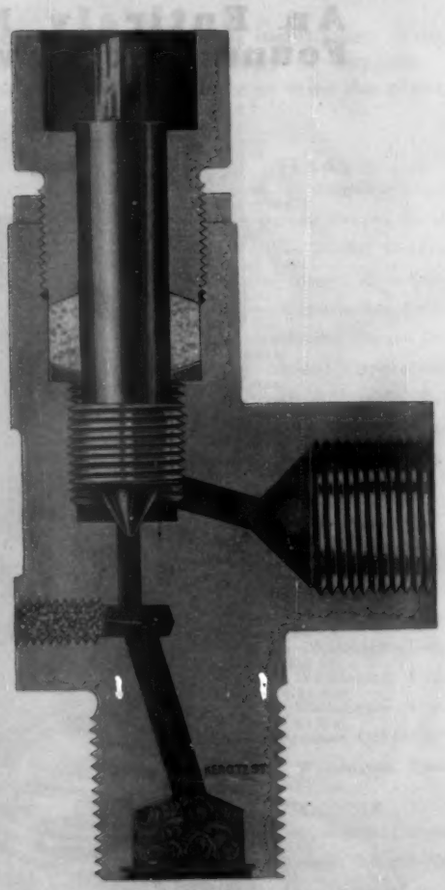

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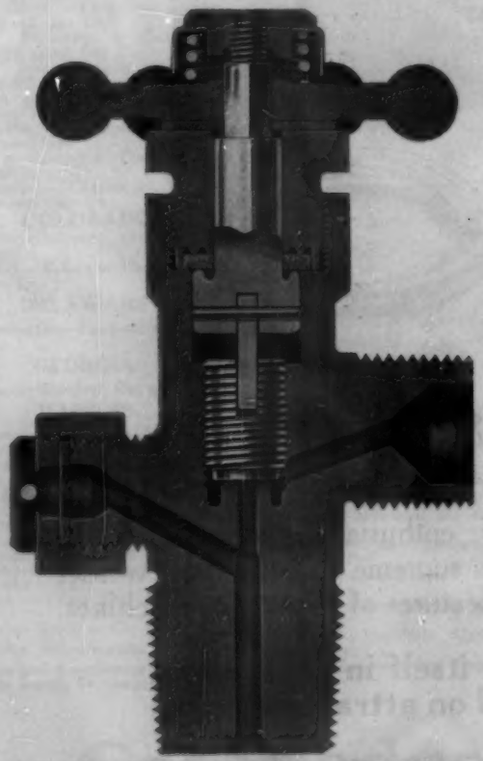

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THERE IS NONE BETTER. For use on

Oxygen	Acetylene
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The "WELDRITE" TRADE MARK REGISTERED

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Always has been superior for general purpose welding of cast iron, steel and malleable, where machines are called on to give continuous, maximum service—Air Cooled, of course—That's your protection.

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"WELDRITE Junior"

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Built for the small welding shop or for manufacturers on maintenance, where requirements are not so severe. Write for the new extremely low prices and terms on these superior machines.

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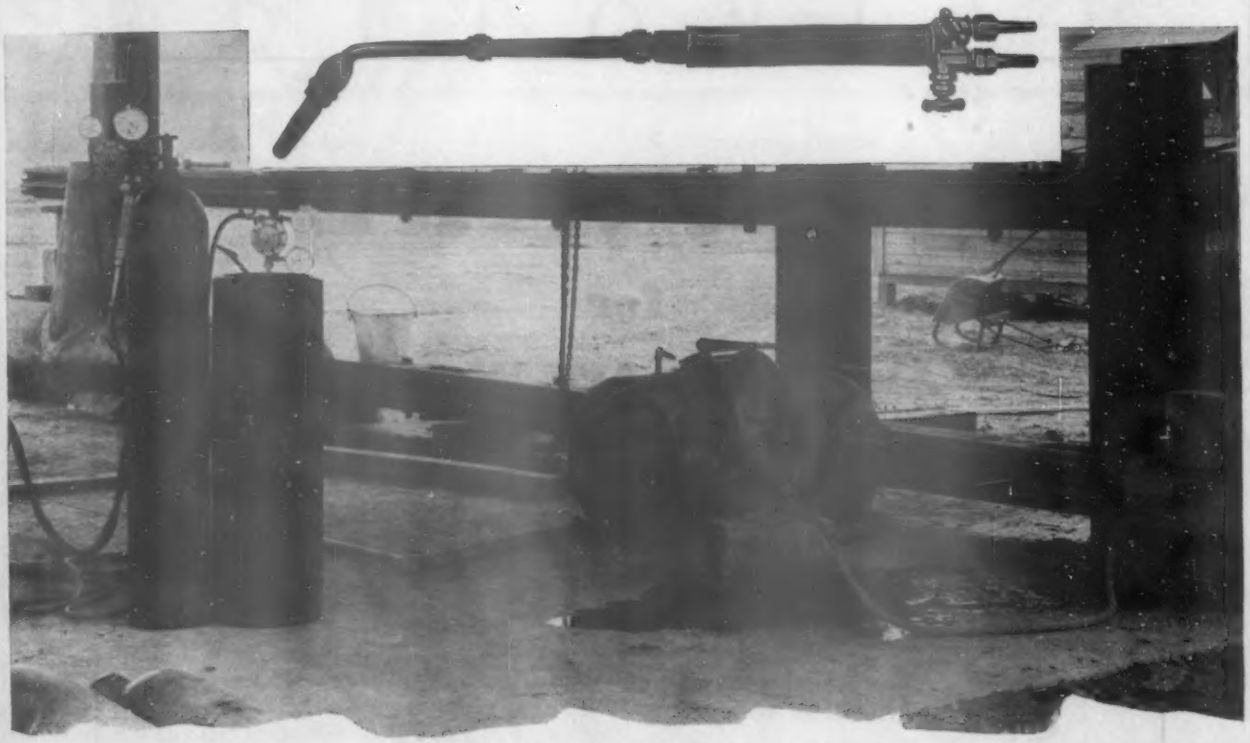
Buy Christmas Seals and help preserve it

THE NATIONAL, STATE, AND LOCAL TUBERCULOSIS ASSOCIATIONS OF THE UNITEDSTATES



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THESE gas welded end plugs for a pipe line came through rigid tests without a sign of failure because they were welded under the most favorable working conditions. MECO apparatus was used throughout, and MECO apparatus is made for this exacting class of work. In its construction is embodied the semi-injector circle mixer for bringing the oxygen and acetylene together. Two hollow concentric cylinders of gas, both flowing in the same direction, are brought together. With this method, eddy and counter currents are entirely eliminated, as well as the collection of carbon and stoppage by other foreign materials. The uniformity of the flame produced is a relief to the welder and allows him to bring into play the utmost of his welding skill. In meeting the rigid requirements of tank and pipe line welding MECO apparatus has no superior.

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Automatic Arc Welding

The well-known REX brand of welding wire for electric welding, as manufactured by the C. H. Hollup Corporation, is now available in reels for use with automatic welding machines.

Reels of **REX** wire can be furnished in three grades as follows:

REX No. 10 Commercially Pure Iron
REX No. 30 Mild Steel
REX No. 150 Annealed Low Carbon Steel

Stock sizes will be 1/8", 5/32", 3/16", and 1/4" but special sizes of 1/16", 3/32", and 5/16" can be made up on special orders.

The particular advantage of the REX brand of wire, which is always furnished with a thin flux coating, is its uniform chemical analysis and its free flowing welding characteristics. It also flows somewhat faster than ordinary bare wire.

Write for free samples and price quotations

C. H. Hollup Corporation

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Manufacturers of

Wanamaker Coated Electrodes and Hollup Arc Welding Machines

EDITORIAL

Profitable Educational Publicity

A PROMINENT life insurance company has for several years worked on a type of advertising policy which merits study by men who have new things to offer in industrial markets. This insurance firm first used space in national magazines to teach health lessons; helping folks to keep well. Then it began to broadcast morning exercises, with the same end in view. More recently it co-operated in an extensive program of business research for the benefit of New England industries, and has put into circulation an intensely interesting booklet which shows what research can do for business. One does not have to look far in the welding industry to find manufacturers who have profited by similar programs of educational advertising. Likewise there have been some who tried and failed because it was quite impossible for them to trust the printed word to build business unless the flavor of sales argument could be allowed to dominate. But the generous volume of real educational material distributed throughout American industries by our manufacturer friends has done its work well, and enough business appears on the sales horizon to justify a lot more of it. The potential market so far outweighs the actual market that to carry on all advertising on a strictly competitive basis would be a sacrifice of real opportunities. Methods of putting this thought into practice can be found by a study of the merchandising plans of successful firms in other industries, and can lead to the solution of business problems within the industry. Sound merchandising principles will always work, and they will work better if unhampered by having to carry weaker ones along with them. Half-hearted educational advertising will yield disappointing results compared to what the real article will bring. The welding industry can make good and profitable use of more of the real article.

Dividends from the Scrap Pile

TWENTY years ago a blacksmith with his helper, under the supervision of a foreman, constituted the entire population of Corwith Yards of the Sante Fe System in Chicago. A small shanty and a remodeled box car were the only buildings in the yard. The story of this reclamation plant is one of a persistent effort to keep usable material from being thrown away as scrap, particularly in cases where a small amount of repair restored worn or broken articles to 100 per cent usefulness. The present plant covers fifteen acres of ground, has a two-story office building, a blacksmith shop, welding shop, tin shop, valve shop, bolt shop, hose shop, brass shop, two rolling mills and a store house, and requires the services of 650 employes. Last year over 11,000 tons of scrap were either used in the manufacture of new material or repaired and made serviceable for further use, the net profit of these operations running well into six figures. Oxy-acetylene welding and cutting play important parts in the work of this great reclamation plant. It is serving in the repair of worn equipment and in the production of new material from scrap metal. Many other kinds of corporations could make generous cuts in their operating costs by watching the corners in the same systematic fashion. All of them admit that the theory is correct but only part of them are willing to use the effort necessary to put the theory to work. There may be easier ways of increasing the dividend rate but there is no way which is fundamentally more sound.

A Promising Trade

AFTER many years of indifferent attention the welder is beginning to arrive at the position he deserves in industry. Salesmen in the early days made the going hard by their calm assurance that the operation of the torch or the arc could be mastered quickly by any mechanic. Their statements were easily accepted for lack of a standard of comparison, and the welders had to be content with what instruction they could get. Not until the uncertainty of results loomed up as a serious bit of sales resistance was it realized that the welder needed help, in the form of good training and good supervision. Now it is customary to develop a suitable technique for every important welding job and to assist the men in mastering it thoroughly, testing them to be sure that they do master it. Welding becomes a department with a competent head who can correct an operator instead of discharging him, and judge whether mistakes are the fault of men, methods, or materials used. A young man can take up the welding trade today with the assurance that there are planty of plants where his work will be as competently directed as that of any other craftsman and opportunity for advancement correspondingly good.

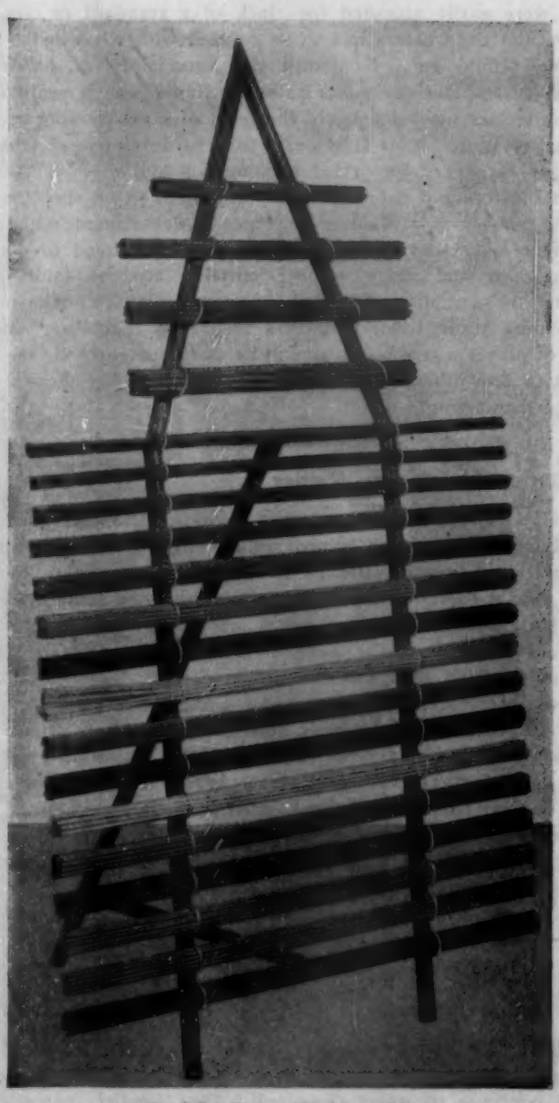
Ventilation Helps the Welder

WHENEVER the proper amount of attention has been given to the matter of providing plenty of fresh air for the welder to breathe, the result in better production has always repaid the effort. There was a time when some operators thought it necessary to use a strong air blast to blow the gases away from the weld, in spite of the undesirable effect of a quick chill on the molten metal. The mistake was one of procedure rather than principle, because the instinct to avoid breathing a poor atmosphere is entirely rational. The correct solution is milder in action and serves the purpose. Either process in a still atmosphere is apt to make it stuffy enough to induce fatigue, and while it is practically impossible for the accounting department to find this fatigue in the cost sheet, it is there. When plant superintendents watch these items which effect the comfort of the worker they accomplish more toward cost reduction than the purchasing agent does in buying materials.

Home Made Hazards

INGENUITY often rushes in where angels fear to tread, in spite of warnings and common sense. And home made devices continue to exact their toll. One fatality, recently reported, seems pitifully unnecessary. The cause of it was a home made gas cylinder which was made to save the expense of using an extra cylinder in a welding shop. It worked, as such things will work, until conditions became just right for it not to work. Users should realize that if more cheaply made apparatus would serve the purpose it would be made that way. Equipment makers are aware of the need for good results and make their apparatus to a definite standard of performance. The substitution of haphazardly made devices does not always involve danger to the user, but may easily involve danger to his customer through the delivery of unsound welds. Don't begrudge the legitimate manufacturer a reasonable profit, especially if it involves taking chances.

Better rod for better welds



A Rod for Every Welding Need
Display rack showing wide assortment of Oxweld welding rods.

YOU CAN'T make angel cake from corn meal. Corn meal is fine for corn cakes, but it just isn't the kind of stuff for making angel cake. You need finer materials.

It is much the same story on welding rods. If you want the best welded joints, you can't use baling wire—you must use the best welding rods. That has been proved time and again by exhaustive engineering and field tests.

Oxweld branded rods are the best because Oxweld cannot afford to sell anything else. Oxweld's business depends on the success of the oxy-acetylene process, and welding rods materially contribute to the success of welding.

Oxweld

WELDING AND CUTTING APPARATUS

OXWELD ACETYLENE COMPANY
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Design for Welded Roof Trusses

One Piece Construction Using Arc Welded Joints Produces Lighter Member Without Loss of Strength or Serviceability

By William Dalton*

A ROOF truss consists of two cord members latticed together by a system of tension and compression members which transfer the compression stresses to the top cord and the tension stresses to the bottom cord. So far it has been the usual practice to use a pair of angles both for the cords and connecting members, with gusset plates and rivets as the means of fastening the angles together. The use of rivets necessitates punching holes in the truss members and these holes cause a greater waste of material than merely that which is removed. The loss is equivalent to a strip of metal the full length and

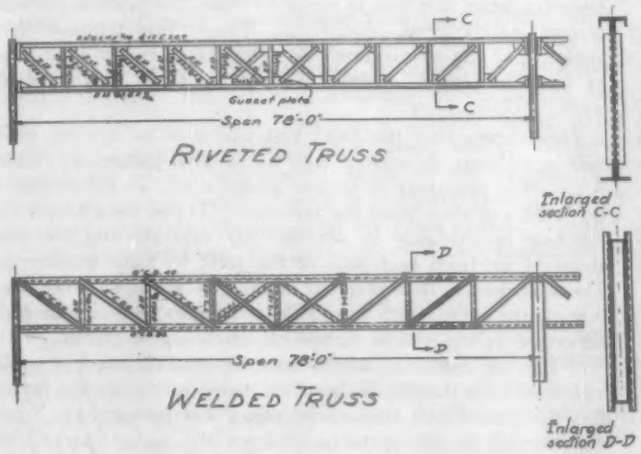


Fig. 1. Riveted and Welded Trusses, Designed for Same Load.

thickness of the member in which the hole is punched and as wide as the diameter of the rivet.

One-half of the connecting members are in compression and the other half are in tension. In compression, angles are not as efficient as H-beams but have been generally used because of the ease of making riveted joints with them. Tension members must be straight when applied so as to prevent a distortion of the truss under load. Channels are best suited for such tension members because they provide more metal directly in line with the applied load than any other section that has flanges to hold it straight.

This analysis indicates that if H compression beams can be economically fastened to channel tension members a truss can be made with the least amount of metal for a given load. It is not easy to rivet this combination of shapes together, but welding provides a means of making the necessary connections. It also avoids the loss of metal caused by rivet holes and does not require the gusset plates needed for riveted joints.

The welded truss design in Fig. 1 is a combination of H compression members and channel tension members which is flexible enough to accommodate the variations in the size of members required for the different parts of the truss. The cords are made of H-beams with flanges placed in the vertical plane. They can be reinforced at the center if necessary by welding extra plates to the webs. The tension channels are fastened to the outside faces of the cord flanges, and the H compression members are fastened to the inside flanges of the cords.

Seats for roof purlins are provided by plates welded to the top flanges of the upper cord. These plates are punched for the purlins and give a connection to the truss without lowering the efficiency of the cord. Where sway bracing is needed, a

Fig. 2. Testing Machine at Rensselaer Polytechnic Institute.

channel is used for the purlin plate with its flanges turned down and punched for the diagonal brace rods.

The riveted and the welded trusses in Fig. 1 are designed for the same load and stresses. Riveted trusses are about 40 per cent heavier than the welded trusses, and bids received for

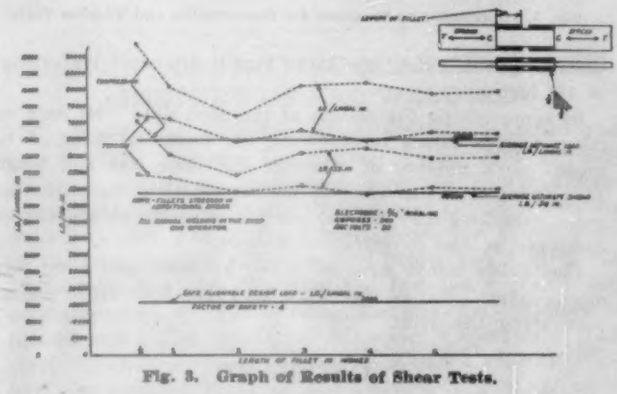


Fig. 3. Graph of Results of Shear Tests.

both constructions show a considerable saving in cost by the use of the welded truss.

That welded joints in structural members may be produced having holding values equivalent to those of riveted joints is demonstrated by a series of tests recently conducted by the General Electric Company. Test specimens were made by

Manufacturing Department, General Electric Company

the General Electric Company, using the metallic arc welding process, and the actual testing of specimens was made under the direction of Professor T. R. Lawson of the Rensselaer Polytechnic Institute, in the laboratory of that institution.

The tests were made on ¼-, ⅜- and ⅜-inch fillet welds, this type of weld being commonly used in fabricating machine parts

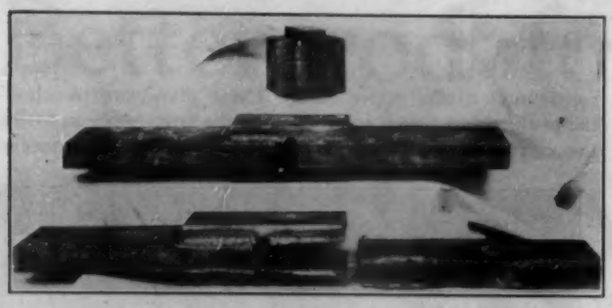


Fig. 4. Tests on Welded Structural Steel, Showing Compression and Tension Specimens After Failure.

and steel structures from standard rolled steel shapes. On each size of fillet there were made tension and compression tests, fillet lengths being, ½, 1, 2, 3, 4, 5 and 6 inches.

A summary of the results of the tests shows that a ¼-inch fillet will stand a safe allowable load of 2600 pounds per lineal inch, using four as a factor of safety. Corresponding values for ⅜ and ⅜-inch fillets are 2900 and 3200 pounds. A ¾-inch rivet will stand a shearing load of 4500 pounds per lineal inch. Based on the results of the recent tests, a ⅜-inch fillet will

Fig. 5. Specimens as Prepared for Compression and Tension Tests.

sustain approximately the same load if deposited for a length of 1½ inches.

In summarizing the results of the fillet weld tests care was taken to use values representing the lowest average of test results on a number of fillets of the same size and length. This is important in view of the fact that, in many machine parts, members may be subjected alternately to tension and compression, and to vibratory stresses.

The welds tested were all made by hand and were made in one layer: that is, the entire fillet was built up in a single pass along the joint.

OBITUARY

L. D. Kelly

With deep sorrow we announce the sudden death of Mr. L. D. Kelly of the Imperial Brass Manufacturing Company, Chicago, Illinois, which occurred on Wednesday, November 2nd. Mr. Kelly was a devoted and capable sales representative, whose fidelity to his house and application to his duties won the respect and good will of his associates and customers alike. In his death the industry has sustained a severe loss.

TESTING WELDS UNDER FIELD CONDITIONS

Periodic testing of a welder's ability is one of the important points in procedure control. Where welding is done under shop conditions, the method of testing welders is relatively simple. At regular intervals the welders are required to prepare test coupons, and these are sent to the nearest testing laboratory for a complete report on tensile strength and other properties of the welds, thus maintaining a constant check on the work.

Where welding is done in the field, as in pipe line construction for example, testing is more difficult. The time required to send test coupons to the laboratory may interfere seriously with the effectiveness of this method of checking. One of the simplest tests to apply is that of bending the welded coupon in a vise until the first signs of fracture are noticed. In evaluating the results of such a bending test, it has been customary in the past to measure the angle of the bend. This method as standardized by the American Welding Society necessitates the use of a large machine in order to make the bend under completely standardized conditions. Recent investigations have shown that the measurement of elongation rather than angle of bend is a more accurate indication of the quality of the weld.

This means that the bend test can now be applied under field conditions in such a way as to give numerical results. All that is necessary is to put gauge mark on either side of the weld and then bend the specimen. It has been found that the best results may be obtained by first starting the bend about ½ in. from each side of the weld by light hammering. The specimen is then inserted in the vise so as to bring pressure on the ends, which causes the coupon to take on a uniform curvature as the vise is tightened. Bending is carried to the first sign of cracking, after which elongation may be easily measured by a flexible scale. The gauge marks should preferably be small punch marks which do not initiate cracks. From the increase in the distance between the gauge marks after bending, the per cent elongation may be very easily calculated. As an indication of what may be expected in an average weld, the elongation should be in the neighborhood of 20 per cent for a weld made in mild steel plate.—*Oxy-Acetylene Tips.*

UNIVERSITY OF CALIFORNIA PUBLISHES STUDY ON MOKELUMNE PIPE LINE

"A Physical Study of the Mokelumne Pipe Line," by Professors L. T. Jones and Walter S. Weeks, is the title of a 75-page book which has been published by the University of California. Illustrated with sixty cuts, showing photographs of stresses and other physical factors, and diagrams showing design of the joints, this able study covers thoroughly the history of the line and the investigation of failures which occurred early in the installation, and recommendations for procedure to overcome the difficulties which developed in the welding of a 60-inch pipe line.

Following are the chapter headings:

Historical
The pipe
Temperatures
Temperature stress
Motion of the pipe line
Pipe line stresses and their measurement
Retaining welds
Closing openings by expansion
Programs for laying, welding, and back-filling of pipe
Ventilation
Conclusions

Copies of this book can be secured from the University of California Press, Berkeley, California.

PROGRESS IN THERMIT WELDING

By C. D. Young
District Manager, Metal & Thermit Corporation, Chicago

THERE were a number of important developments during the year, one of which has to do with the improvement of the Thermit itself, and resulted in the substitution of Forging Thermit for Railroad Thermit. Thermit steel differs from ordinary cast steel principally because of its freedom from impurities on the grain boundaries and many of the properties which ordinary cast steel has are really due to the impurities in the cast steel rather than to the material itself, so that when we research in the field of Thermit steels, we unfortunately can learn very little from the conclusions arrived at by others and must literally start at the beginning. This lack of impurity at the grain boundaries in Thermit steels is due, of course, to the very different method by which the steel is made.

In general, ordinary steel is a refinement of pig iron, and in the various steps down to the manufacture of cast steel or the ingot from which rolled steel is made, the steel is gradually refined impurities eliminated but never completely. Thermit steel starts with the purest possible materials in the form of iron oxide and aluminum, and impurities are almost entirely absent. The result is strikingly shown by the fact that ordinary cast steel fractures principally along grain boundaries, whereas Thermit cast steel always fractures through the grains themselves. Much of the improvement which rolling and working does to ordinary steel is due to the breaking up and elongation of the grain boundary so that this inherent weakness is eliminated, and our conclusion is that Thermit cast steels without this impurity have all the properties of a high grade forged steel.

These facts have been proven so thoroughly that Thermit steel welds are now allowed in new forged steel structures with the knowledge that the cast Thermit steel will have all the properties of the forged steel, and this has opened by a wide field, allowing simplification in design by the joining of simpler forgings in the construction of complicated pieces. The first important instance of this was in the making of forged steel stern frames for ships; the Classification Societies at first argued that the purchaser of a new ship had the option of selecting the cheaper cast steel frame or the more expensive forged steel frame and, therefore, since the frame would be no stronger than its weakest point, they would not allow a cast steel weld to be used in the construction of forged steel frames. After a series of tests, however, they, too, agreed that the Thermit weld, although producing what was technically cast steel, nevertheless had all the properties of forged steel and consequently these Thermit welded constructions were allowed.

This important fact has gradually been proven to the steel mills themselves and they too are using Thermit for the joining of forgings, simplifying the design, and in many cases greatly increasing the life of these heavy parts so that the old tendency of carrying great numbers of spare parts, of throwing the broken ones back and making them over is gradually disappearing, and we see in the steel mills the substitution of what we have called Thermit Reclamation Departments. Rolls are now made using one grade of steel for the body of the roll and an entirely different grade for the wabbler ends, so that each part can best stand the service to which it will be subjected and these parts are Thermit welded together; or, in many cases, the rolls are made all of the same material as in the usual practice, put into service and then in a few weeks when the wabbler ends have worn down, these are built up by the addition of an extremely hard and tough Thermit steel containing a high manganese and a high carbon content, which although it might not be suitable for the body of the roll itself, nevertheless presents a wearing surface in the wabbler end which greatly outlasts anything which hitherto has been obtained. So, during the year, we have seen the development and marketing of Forging Thermit which produces a steel with almost the same ductility that the old Railroad Thermit steel used to have, but which has a tensile strength of at least 70,000 lbs. per square inch; and we have also seen the development of the present superior wabbler Thermit which can be used to deposit an extremely hard material which will give unprecedented wear.

Paper read at Welding Conference, Purdue University, Lafayette, Indiana, Dec. 14, 1927.

WELDING AND KILOWATT-HOURS

The following constructive editorial in the December 6 issue of "Power" is further evidence of the growing recognition of the advantages of welded machine and building fabrication:

"Rapid strides in the application of welding are forecasting changes in many branches of industry. One of the most interesting of these changes is the promise of lower power-generation costs that should follow the full and proper use of this method of fabrication in the industrial-power plant.

"Unit costs of power generation are made up, to a considerable extent, of fixed charges on buildings and equipment. Anything that reduces building and equipment costs reduces the fixed charges on them and, therefore, reduces the cost per generated kilowatt-hour. Welding can be used to reduce these charges in two ways.

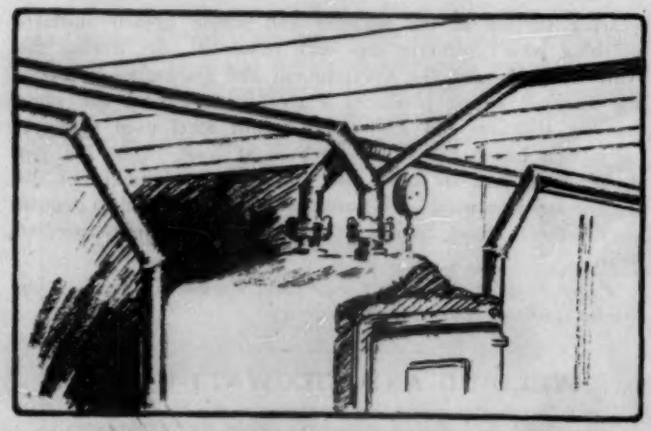
"Fabrication of equipment by welding makes great savings. Parts formerly made of cast iron can be made of steel plates, sheets or shapes at about one-third the cost per pound of metal used. And since steel is stronger than cast iron, fewer pounds of metal need be used. Consequently, equipment can be made both lighter and cheaper.

"Buildings can be made cheaper by the use of welding: First, because the equipment in them is lighter when welded, and hence needs a lighter foundation; and, second, because welded steel frames can be used in place of riveted steel frames at a saving in metal weight and hence in building cost.

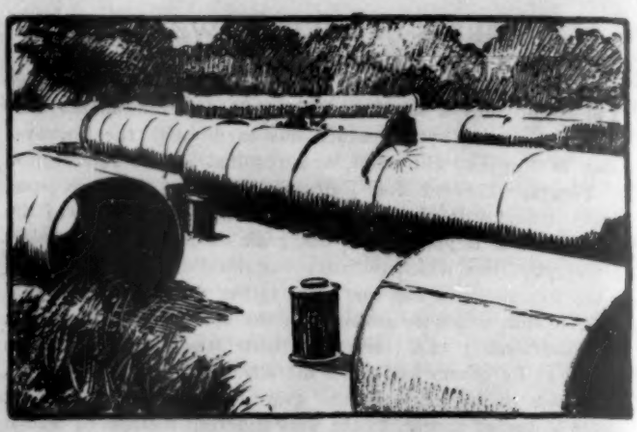
"These savings in building and equipment cost, when realized to the fullest possible extent, will make an appreciable difference in the cost of power generation. Thus industries that so use welding will be better able to use the product of industrial power plants. The obvious conclusion is that power plant engineers will benefit by the increased use of welding and should, therefore, give it their enthusiastic support."

BALDWIN LOCOMOTIVE QUARTERLY TELLS HISTORY OF ARC WELDING

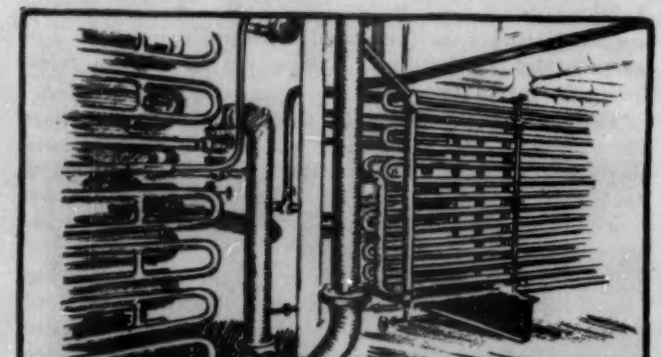
The latest issue of "Baldwin Locomotives," published quarterly by The Baldwin Locomotive Works, includes in its 72 pages articles on such interesting and widely different subjects as Logging in the Philippines, Uintah (Colorado) Railway Views, The Moffat Tunnel Road, The Jarrah Forest of Western Australia, Modern Tool Steels, and A Brief History of Electric Arc Welding, the last being printed with acknowledgment to *The Welding Engineer* for the story and illustrations. This article, by Alexander Churchward, Technical Director of Wilson Welder & Metals Company, begins with the work of Benardoz and Demeritins with the carbon arc back in 1880, through the first practical applications and the steady development to the present-day welding machine using either the carbon or metallic electrode. Numerous applications of the process are described and illustrated, including welding on structural steel, railway rails, pipe lines, machine parts and castings.



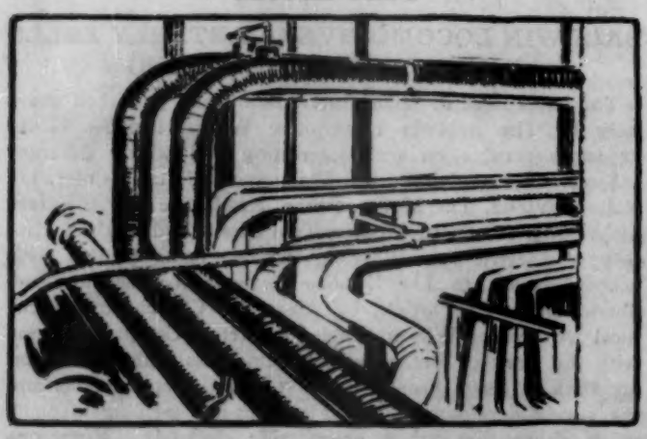
This drawing was made from a photograph of a portion of a house heating system which was assembled by welding. Experience showed the owner that the cost of welding was less than the cost of putting the system together after the fittings were provided. Connections such as the ones shown above and bends made by heating the pipe with the oxy-acetylene torch eliminated a great many screw connections and fittings; furthermore the heating plant itself turned out to be more convenient as well as leak proof.



Successful welding of pipe lines does not depend so much upon the size of the pipe as it does upon the understanding of pipe welding procedure. Huge water pipe lines have been successfully welded under a great variety of conditions and apparent handicaps. A study of the work which has been done in this direction would seem to indicate that the only limitation on the amount of pipe line welding which can be done is the limitation imposed by lack of knowledge on the part of those in charge of the construction.



A rather intricate piping assembly, like the one shown here, is being successfully welded on a production basis. The efficiency of the equipment was greatly increased at a lower cost because welding made possible the introdution of a new principle of design which would have been very impractical if any other type of connection were used. It is typical of the process that wherever it is applied to this kind of work it has the effect of a simplified construction.



It is difficult to estimate just how valuable welding is in the construction of assemblies such as the one shown here because in addition to the more economical fabrication cost we have to consider the advantage to the user secured by the elimination of dozens of possible leak points. Welding was first considered in connection with pipe work because it promised to get rid of losses occasioned by leaky joints.

The Best Way t

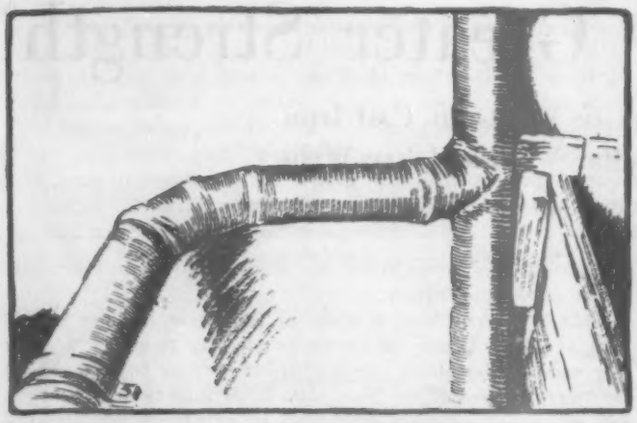
There Would Be More Welding of Pi Those Who Planned Buildings K ew Me

IF the fusion welding processes had been perfected early enough in the history of civilization it is doubtful that many of the now common types of mechanical pipe joints would ever have been considered necessary. Their present necessity arises from the fact that pipe installations must necessarily be shipped in convenient short lengths, and joined on the job. We use fittings for this joinery because our forefathers used them and went to great pains to make the best possible connections with them.

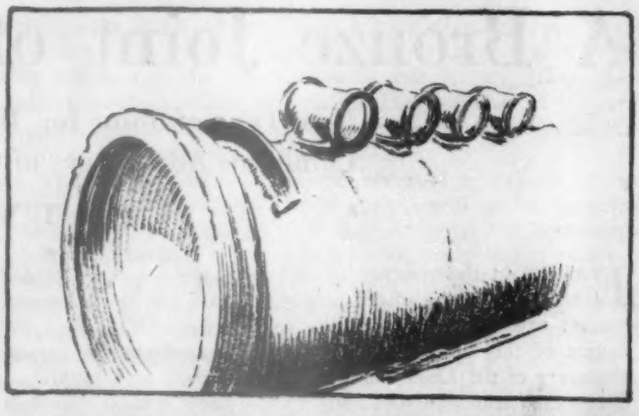
To justify reference to welding as the right way to join pipe, it is only necessary to point out that mechanical joints introduce two serious defects, a weak point and a possible leaky joint. Welding when properly done practically eliminates the joint, producing a continuous piece of tubing which is near enough to being perfectly homogeneous to meet any requirement of pipe line service. This fundamental characteristic of welded piping is the basis for all the advantages which have been claimed for the use of welding in this field.

More extensive use of welding in pipe work must wait upon the spreading of information that the process is not limited in its application to any particular kind of pipe assembly or to any small group of such. The factory superintendent may easily conclude that welding is fine for a line that is to be laid across a fast moving river, or up the side of a steep mountain, or across a blazing desert, but would be risky for his steam lines, when those very steam lines could be welded with far less difficulty, and with complete certainty of getting a more perfect line than could be constructed by other means.

The habit of considering certain types of pipe joints to be necessary because they have been in sight and under observation for generations is a hard habit to break, in spite of the fact that those joints have quali-



No change of direction or dimension will puzzle the piping contractor who knows his welding and cutting torch. It is on jobs like this that the most spectacular savings by welding have been reported. In this connection it should be noted that whereas a slight change in dimension from original specifications might mean a considerable expense if cross fittings were used, such changes involve practically no expense in a welded job because of the extreme flexibility of the process.



It has been assumed in many cases that cast iron pipe is not included in the field for pipe welding. It is a fact, however, that cast iron pipe lines are being installed successfully by welding and cast iron pipe manufacturers are making elaborate combinations like the one shown above, with the aid of the welding torch. This is neither experimental nor occasional work but part of established production procedure.

to Join Pipe

of Pipe in Industrial Plants if ew More About These Advantages

ties which compositely amount to a thorough nuisance. It just seems unbelievable that such weak spots in construction can be replaced by a smooth, continuous length of strong pipe. Another hard thing to believe is that highly respected engineers and architects should go on specifying the use of the old fashioned joints if they were not essential to the construction. This is easily explained by the lack of knowledge of welding at the time these men learned their professions. The task of breaking this habit promises to be a more or less tedious one, but tremendously worth while on account of the improvements in construction which will result wherever metal pipe is used.

A little thought given to the present status of pipe welding will serve to show one of the reasons why the process is not more generally used today. It could not be popularized over night, like halitosis, because welded pipe cannot be served over the counter in twenty-five cent bottles. Every new application had to be supported by pioneering work in design and costly experiments to make sure that no chances were being taken with the end result. The important fact is that leading engineers in industries making great use of pipe have tried it with success, and are its most enthusiastic advocates. It is not the small, unknown firms, but responsible organizations of nationwide reputation, who have put the stamp of engineering approval upon welded joints for pipe.

By this time, much of the early pioneering work has been in service long enough to give a good account of itself, and the welded pipe system with the double advantage of lower cost and better service is beginning to become quite popular. It is not long that the welding industry will have to wait for the public to demand welded piping, so the present is a good time to make preparations for the new work.

Here is the answer to the question often raised about welding in extreme weather conditions. A steam pipe line between two large plants was successfully welded in below zero weather. Welding was used in this case because the owner wanted the best and most reliable line that could be built. Pipe lines have also been successfully welded in the hottest countries and over the most difficult terrain.

Although industrial pipe welding is still in its infancy hundreds of plants already have lines installed with the aid of this process and the advantages in favor of welded lines are immediately evident to the plant engineer. Joints are made at lower cost, wide angle bends give better flow, the installations are more compact, the insulation is better and less expensive to apply, the line has a better appearance, and it is extremely easy to make any kind of alterations which may be desired.

A Bronze Joint of Greater Strength*

New Type of Joint for Bronze Welds in Cast Iron Combines Advantages of Collar Weld and Vee Weld

By T. W. Greene†

EARLY in the summer of this year, there was concluded an investigation of the proper methods for laying bronze-welded cast iron pipe with the collar-type joint. During the course of this investigation, which was conducted jointly by engineers of the Linde Air Products Company and the United States Cast Iron Pipe and Foundry Company, it became evident that the collar type of joint had certain defects. Since a strong leak-proof joint for cast iron pipe is one of the most important problems confronting the gas distribution industry, it seemed desirable to review the entire question of the design of joint for bronze welding of cast iron pipe.

In the early stages of bronze-welding development several types of joint design were investigated, namely, the vee, collar, and combined vee and collar. Tests made on strips cut from the pipe showed that failure occurred in the cast iron adjacent to the bronze for all cases of collar type design, whereas the simple vee type failed along the bevel. Since the collar design took advantage of the well-known high shear strength of bronze adhering to cast iron, and furthermore since all of the breaks with the collar type occurred in the pipe itself, it was decided that the collar was the correct design and this type has been used almost exclusively in all installations.

Flexure Tests Show Weakness of Collar

Since the early tests were made simply on strips cut from the pipe and since the present investigations seem to indicate that the collar type joint was not as strong as it was thought to be, it was deemed advisable to make cross bending tests on full size 12-foot sections. Both plain and jointed pipe were tested. Tests were made in a 100,000 lb. testing machine, using a 14-foot length of 10-in. I-beam as a base. Rocker supports were mounted on the beam to hold the ends of the pipe sections. Pipe was tested as a simple beam, lead being applied through a rocker knife edge at the center of the span, which was 10½ ft. in practically all cases. Jointed samples were prepared by bronze-welding two 6-ft. sections together, using the collar type weld. The load was applied directly to the collar so as to produce the maximum bending moment and stress at the joint.

The results of these tests, summarized in Table 1, show that the strength of the bronze collar joint is only about 55 per cent of the strength of the pipe itself when deLavaud pipe is used. With sand-cast pipe, the collar joint is considerably weaker, having only about 42 per cent of the strength of the pipe. In all cases failure occurred in the cast iron at the edge of the collar. The collar type weld apparently has a decided weakening effect on the cast iron next to the joint, causing failure at about half the strength of the unjointed pipe.

Collar Failure Due to Stress Concentration

Numerous theories have been advanced as to the cause of the weakness of the joint or of the cast iron adjacent to the bronze weld. Careful investigations have shown that the bronze welding operation produces no change in the chemical properties or physical structure of the cast iron adjacent to the bronze weld. If this is the case, why does failure always take place in the cast iron immediately adjacent to the bronze collar? The answer as determined by the present investigation lies in the mechanical design of the collar joint. There is a concentration of stress in the cast iron next to the bronze collar which causes the failure.

This is evident from a study of the stress transfer in this type of joint. It may be shown graphically as in Fig. 1. For any metal under strain stress distribution may be represented by "lines of stress" or "flow lines." If load is uniform over the cross-section, these lines will be evenly spaced. If the distribution is upset, stress concentrations will be represented

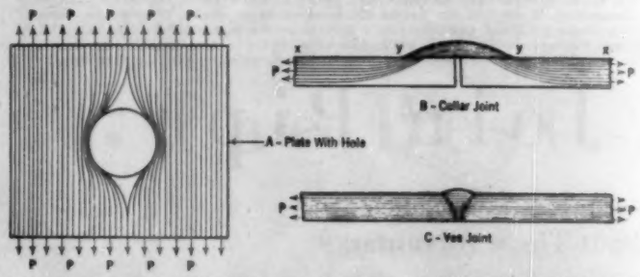


Fig. 1. Stress Transfer Diagram, Showing (B) Stress Concentration at Y—Y and (C) Uniform Transfer of Stress P—P Through Vee-Weld.

by the bunching and crowding of the line. As an illustration, consider a plate subjected to a uniform load as in A in Figure 1. Along the sides of the plate the stress lines are uniformly distributed, but at the center where a hole has been cut in the plate, the stress lines must flow around the opening to transfer the stress in that section and there is a bunching of the flow lines at the edge of the opening, indicating high stress concentration at this point. That such is the case is well an established engineering fact and the stress is three times that in the rest of the plate.

When a stress transfer diagram is made for the collar joint as in B, Figure 1, it is immediately evident that there is a very decided stress concentration in the cast iron next to the joint, as shown at y. The stress at this point may be two or three times the stress in the pipe farther away from the joint. With the collar type joint in cast iron, the fibres in the section next to the bronze will be stressed to the point of fracture under a relatively low load since that may be under a stress concentration of over twice the average in the pipe. It is at this point in stress concentration that failure invariably occurs.

TABLE 1—FLEXURE TESTS—CAST IRON PIPE

	Modulus of Rupture lb. per sq. in. (average)	Joint Efficiency Per cent (average)
6-in. deLavaud cast iron pipe:		
Plain pipe	34,500	100
With Collar type bronze weld	19,000	55
With vee type bronze weld	28,750	83
With shear vee bronze weld	32,950	96
6-in. Sand Cast Iron Pipe:		
Plain pipe	27,170	100
With Collar type bronze weld	11,450	42
With vee type bronze weld	21,500	79
With shear vee bronze weld	27,500	100

Vee Type Joint Gives Better Stress Transfer

To effect uniform transfer of stress from one section to another through a joint, the simple vee type is much more effcient. As shown at C, Figure 1, there is practically a straight-line transfer of stress through this type of joint. As mentioned previously, the vee type joint was tried in the early experiments of bronze welding cast iron pipe, but the tests seemed to indicate that this joint was weaker than the collar type. However, it is now known that failure in these tests

*Paper read before 28th Annual Convention of the International Acetylene Association, Chicago, Nov. 18, 1927.

†Engineering Dept., Linde Air Products Co., New York.

was due not to the design of the joint but to improper preparation of the beveled surfaces of the pipe.

When cast iron pipe is machined, the machined surface is extremely difficult to tin and there is very poor adhesion of the bronze to the surface, due apparently to the graphite flakes that are exposed. This machined surface is easily decarbonized by annealing to a bright red after which the tinning operation becomes practically automatic. Since this fact became known it has been standard practice to machine the ends of cast iron pipe and anneal for bronze welding. Unfortunately this necessity for annealing was not known by the earlier investigators of the vee-type joint.

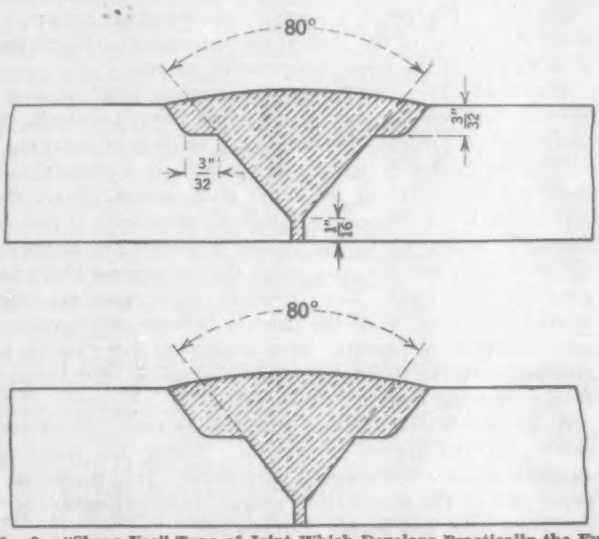


Fig. 2. "Shear-Vee" Type of Joint Which Develops Practically the Full Strength of Plate or Pipe.

Simple Vee Stronger Than Collar

In order to check the theory that the vee-type joint made on properly annealed beveled surfaces should show a much higher strength than the collar type joint, it was decided to make cross bend tests on full-sized pipe, using the vee type joint. Results as summarized in Table 1, show that the reasoning was correct for the strength has increased to 79 to 83 per cent of that of the plain pipe. It is interesting to note that this simple vee joint, although its strength is not quite equal to that of the pipe, is more efficient than any known mechanical joint.

A study of the type of failure brought out some very interesting points. Failures occurred in every case along the vee. Generally a fracture in deLavaud pipe showed a layer of cast iron adhering to the bronze at the bottom of the vee or at the inner part of the pipe wall. The outer part of the wall fracture followed along the tinned surface of the bevel, leaving a very thin coating of bronze on this part of the pipe.

"Shear-Vee" Joint Develops Full Strength

This type of failure showed that the adhesive strength between bronze and cast iron in tension was not fully equal to the high tensile strength of the deLavaud pipe. Therefore the simple vee joint was redesigned to introduce a shear area, thus utilizing the known high shear adhesion of bronze and cast iron to assist the tensile adhesion along the bevel. Results of flexure tests summarized in Table 1 show that this new "shear-vee" type of joint, Fig. 2, develops practically the full strength of the pipe.

Failures occurred in the cast iron showing that the full strength is obtained when the vee type joint is reinforced by a small shear area.

Further tests of the shear vee joint were made by preparing hydrostatic bombs. Two 2-foot lengths of class 150 deLavaud pipe were united with the shear-vee joint. The ends were closed with steel bull plugs to insure uniform stress distribution in the bomb. Two of these bombs were made and tested to destruction with hydrostatic pressure, one requiring 27,800 lb. per sq. in.; the other 24,500 lb. per sq. in. These agree closely with published data on the bursting tests of cast iron pipe. Both bombs fractured longitudinally in the pipe, the bronze weld appearing to be unaffected.

The most economical design is obtained by using a 40 deg. bevel with the additional shear area about $\frac{1}{4}$ in. from the outside of the pipe wall. For ease in laying and economy in cost, this distance seems to be constant for practically all wall thickness of the pipe.

The shear-vee type joint is a modified combined collar and vee joint with the bronze within the limits of the pipe wall. With this joint there is no detrimental stress concentration or eccentricity.

In welding this joint, little or no thickening or reinforcement is required. The bronze has an ultimate strength greater than the pipe itself, so a depth of weld equal to the thickness of the wall is sufficient.

Advantages of Shear-Vee Joint

The shear-vee joint for bronze welding cast iron pipe has numerous advantages over the collar joint, besides being decidedly stronger. From a welding standpoint, the joint, if properly prepared, is easier to make. With the collar joints, considerable difficulty is encountered by operators not experienced with this construction, in making the collar of correct dimensions and in equally spacing it over the abutting pipe ends. An excess amount of bronze was used with this joint, which, since it constituted the largest individual item of cost, made the joint needlessly expensive. With the shear-vee joint, the dimensions are controlled and guided by the nature of the design. All that is necessary is that the vee be filled. The cost of this joint, which includes machining the pipe ends correctly, is slightly less than that of the collar type. It is, however, more expensive than the low-cost vee joint, which is approximately 25 to 50 per cent cheaper than the collar type.

Searing, or annealing, which costs the same as for the collar type, is done at the pipe manufacturer's plant. It should not be attempted with the blowpipe, except where absolutely necessary for special construction in the field, as it may easily be improperly done.

The much higher strength of the vee and shear-vee types of joint has significant importance in considering the success to be obtained with bronze welded cast iron lines. The field experience with bronze-welded collar construction showed that even with a joint of only 40 to 50 per cent the strength of the pipe, failure occurred in only about 2 per cent of the total joints laid. Ninety-eight per cent of the joints, consequently, were subjected to strains less than 10,000 to 18,000 lb. per square inch intensity, as otherwise failure would have resulted. Of the 2 per cent that failed, the stresses probably were just in excess of the strength of the collar joints. It can readily be seen, therefore, that an increase of 100 per cent in the strength, as obtained with the shear-vee joint, will mean the elimination of the few breaks which did occur. Moreover, in the early laying of bronze welded lines with the collar joint, no particular care was exercised to minimize either the temperature or bending strains as it was believed the joint was stronger than the pipe and would withstand any stress. However, bronze welding converts the sections into a continuous tube of cast iron and tensile stresses from bending and temperature must be controlled within safe limits. Safety can be assured by exercising a reasonable amount of care in laying and by effectively using expansion joints.

The bronze joint has a lower electrical resistance than any of the common joints used with cast iron pipe; hence it conducts any stray currents which may be traveling the line without the joint being attacked by electrolytic action, as may occur when a high-resistance joint causes the current to leave and re-enter the line.

(*Continued on page* 39)

Stainless Irons and Steels

A Study of the Corrosion Resisting Steel Alloys and How Changes in Composition Affect Working Qualities

By J. B. Green*

THE name "Stainless Steel" is in some ways quite a misleading one. It was first used for cutlery and because fruit juices, etc., did not tarnish the knives, "stainless" was a logical name. This steel does not always hold a good cutting edge and so its first use in the form of cutlery is now generally looked on as probably a less important application than at first. The name "stainless" still is used and no doubt always will be. It has now, however, been made to apply to a large number of alloy steels all containing chromium and all being quite highly resistant to corrosive actions such as rusting, chemical corrosion, and scaling at elevated temperatures. It is thus more proper to either speak of stainless steels, using the plural,

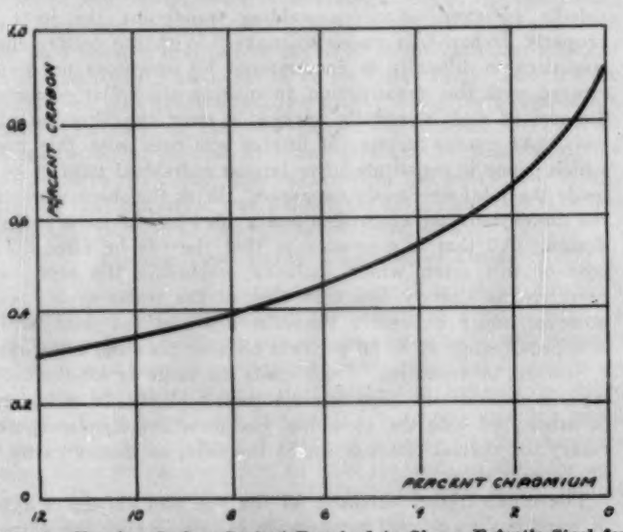


Fig. 1. Showing Carbon Content Required to Give a Eutectic Steel for Varying Chromium Content.

or else mention a specific type, brand or analysis. There are already a great many types or brands of stainless steel on the market and new ones are being added at frequent intervals. Each has its special field of application and each differs rather widely from the other in resistance to corrosion and physical properties and the difference between types is especially great from the welding standpoint.

There are two main groups among the numerous types. These are the straight chromium-iron alloys and those that contain not only chromium and iron but one or more other metals. Then there is another classification based on the carbon content. This subdivides each type into stainless steel and stainless iron, the latter having the lower carbon content. Before describing the various types and subtypes, something must be said of the general significance of chromium when alloyed with iron. In the following discussion, completeness and detailed accuracy will be somewhat sacrificed for the sake of brevity. Metallurgists, who care to study the subject in detail, are referred to "Stainless Irons and Steels" by J. H. G. Monypenny, obtainable from the *Welding Engineer*. Also for the sake of brevity, a few technical terms, as used by the metallographist, will first be explained and then employed.

Pearlite—The form taken by the carbide in Steel which is represented by alternate layers of carbide and pure iron. These layers are called "lamellae" and such a metal structure "lamellar." Pearlite is a normal constituent of carbon steels from the lowest to the highest carbon content. Furthermore, it is normal at the lower temperature ranges.

Eutectoid—The pearlite in low carbon steel appears as patches between the pure iron (called ferrite) crystals. The more carbon present, the larger the patches of pearlite. By raising the carbon content to about 0.85% in a straight carbon steel, the patches cover the entire cross-section. Steel, therefore which is wholly pearlite is called "eutectoid". If still more carbon be added, the excess carbide is thrown out at the crystal boundaries and the steel under the microscope looks somewhat like mild steel. Now, however, the crystals are pearlite instead of ferrite, while the patches between the crystals are carbide instead of pearlite. Steel containing more carbon than required to make it wholly pearlitic is called hyper-eutectoid, steel containing less, hypoeutectoid.

Austinite—A solid solution of carbon in steel. There are no patches at the crystal boundaries. Under the microscope, austinite appears like a single pure metal. It is normal at the upper end of the temperature range. It is non-magnetic, extremely ductile, and harder than ferrite.

Martinsite—A transition constituent resulting from a partial breakdown of austinite toward pearlite. It is extremely hard and brittle.

Steels are, depending on their carbon content, (1) hypoeutectoid, (2) eutectoid or (3) hyper-eutectoid. If heated to a sufficiently high temperature, all steels are austinitic. If cooled quickly enough, this austinite remains unchanged. It is impossible to cool some steels quickly enough, and consequently on quenching they become martinsitic or extremely hard. By reheating, part of the martinsite is permitted to change to pearlite, or other intermediate forms, and a much softer constituent results. This is the general theory of hardening and tempering steels.

As chromium is added to carbon steel, the content of carbon required for eutectoid composition is reduced. This is due to the fact that the carbide plates or lamellae making up the pearlite are spaced farther apart. The pearlite is said to be dispersed. In Fig. 1, is plotted the carbon content required to give a eutectoid steel for varying chromium contents. It will be seen that, as the chromium contents goes up, the carbon required drops sharply. While there is no set rule, still it is general practice to call the stainless alloys "iron" when the carbon content is low enough to give a hypo-eutectoid structure and "steel" when high enough to give one which is hyper-eutectoid. These are very useful points to remember in selecting a particular brand of stainless steel for any specific application. Nearly everyone is familiar with the behavior of straight carbon steels of various carbon contents. Knowledge of the effect of chromium on the structure of such steels permits reasoning from what is known of the carbon steels to what may be expected of any particular stainless steel so far as its behavior in connection with heat treating and working is concerned.

There are three principal types of straight chrome steels, containing 12% to 14%, 17% to 18%, and 25% to 30% of chromium respectively. Then there are four other types each containing another alloying metal in addition to chromium. These other alloys are nickel, silicon, copper and molybdenum.

*President, Fusion Welding Corporation, Chicago, Ill.

This makes seven different general types and, of course, a wide choice of analyses in each type is possible through variation of the carbon content and percentage of alloying metal other than chromium. In addition to these general types, there is almost an infinite variation possible in the matter of special types. The name stainless steel is not an exact term and some manufacturers prefer to say that their product is not such a steel while others, making a quite similar alloy, say their product is stainless steel. The majority would probably call an alloy of chromium and iron possessing a decided resistance to various forms of corrosion a stainless steel or iron, depending on the carbon content. In general, the higher the chromium content and the lower the carbon content, the less susceptible the alloy is to heat treatment. This is another important consideration in selecting the most suitable type for a specific application. On the other hand, as the chromium content is increased so is the buying price. Up to this point, the commoner types of stainless steels have been mentioned and a basis for estimating their physical properties presented by comparing them with the better known straight carbon steels. As it is usually necessary to work metals either cold or hot in the process of fabrication into finished articles, a knowledge of the properties on which such working depends is important to the manufacturer.

Of equal importance to the user is a knowledge of the resistance to corrosion of the various stainless steels. Hardened and properly tempered these steels offer their greatest resistance to corrosion. They are practically immune from attack when exposed to the atmosphere or to water either fresh or salt. In general, they are not attacked by organic acids or the alkalis or many salts of the alkali metals. The mineral acids do attack these steels, some of them only slightly, however. The point is that stainless steels resist much natural and chemical corrosion but not all and that this resistance varies as between the different types of such steel both in degree for any one corrosive medium and as between different media.

This phase of the subject is too extensive and complex to be discussed in this article. The most practical way to handle the matter, is to obtain the advice of the manufacturer, a list of all those in the United States being appended at the end of this article. Many suggestive applications of stainless steels may be found in an able article by Mr. W. C. Johnson, appearing in the *Welding Engineer* for October, 1926.

Still other applications are washing machines, cream separators and other dairy machinery, laundry machinery, bakers machinery, soda fountains, ice cream freezers, steam turbines, locomotive and other high pressure steam valves, nitric acid containers, automobile door hinges, and others too numerous to mention.

Probably one of the most interesting, because the possible volume of business is so great, is the application of stainless steel to what might be best described as fired vessels. Thousands of tons of such vessels are manufactured and consumed largely by corrosion each year. Annealing and heat treating boxes and pots are used in enormous quantities by various branches of the steel producing and metal working industries. Most wild steel sheets, wire and strips must be annealed in process of manufacture. Fired vessels are required in the malleable iron industry, in the ceramic industries and others. Both Tool Steels and Automotive Steels must be heat treated on a large scale. Fired vessels must be used in the form of huge stills in the petroleum and other lines of chemical manufacture. The tendency in steam boiler manufacture is toward the use of temperatures so high mild steel will no longer be suitable. An informal survey recently made of the sheet steel industry indicates that many thousand tons of annealing boxes are consumed each year largely because of scaling at the elevated temperatures employed.

The fact that stainless steels generally possess very much higher strengths at high temperatures makes it possible to use much thinner materials, so much thinner, in fact, that the increased cost of stainless steel might be offset by this fact alone. In general, the higher the chromium content, the greater the resistance of the alloy to scaling at elevated temperatures.

The application of stainless steels is essentially a problem in Redesign Engineering.* It is primarily a matter of better meeting extreme conditions. Welding bids fair to enter the picture in a very important position. As most articles of manufacture for which stainless steels are suitable must be caulked tight and stay that way under the extreme conditions to which they must be subjected, welding quite naturally is the logical means of doing this. Rivets have been developed by the Champion Rivet Company, Cleveland, Ohio, and the Canton Bolt Co., Canton, Ohio, for joining stainless steels and it is

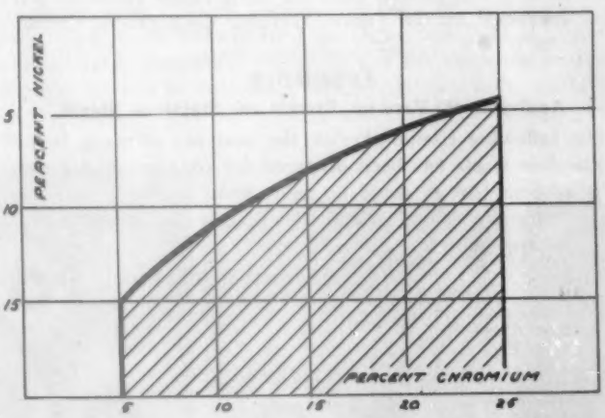


Fig. 2. Nickel-Chrome Compositions (Shaded Portion) Giving Base Metals Suitable for Welding.

said that they are a practical means of joinery. It appears to the author, however, that if welding offers the advantages that it so generally does in mild steel joinery, it must offer still greater advantages in stainless steel joinery. It would seem that all the advantages of welded joints over riveted both as to cost and quality would be retained and another added, viz., that of caulking to meet the extreme conditions that furnish the excuse for stainless steels.

The welding of stainless steels is not an easy matter as some authorities would lead the public to believe. Stainless steels can all be fused by any of the welding processes and if mere fusion and welding are considered synonymous, then it is an easy matter to weld these alloys. Commercial requirements go way beyond mere fusion. The welds must be sound. They must be made successfully and regularly by men who are available in numbers, not by the occasional genius that appears at the employment office only at rare intervals. The welds must be made cheaply. The fluxes used should not give off free flourine gas obliging production welders to use gas masks in addition to goggles, gloves and all the other protective equipment they are already burdened with. Calcium flouride has, until recently, been the only really successful flux for stainless steel welding, and this fact is back of the preceding remark. Brittle base metal, where such is inconsistent with the use of the article in question must not occur adjacent to the weld.

A few remarks with reference to the brittle range just outside the weld in many stainless steels is in order here. Near the beginning of this article, the effect of heat treatment on stainless steels was explained by comparison with straight carbon steels. Welding stainless steel results in an air quench and conequent hardening of the base metal adjacent to the

**For a more complete discussion of the significance of "Redesign", see the author's article in the April, 1927, issue of the Welding Engineer.*

weld. The higher the chromium content and lower the carbon content the less susceptible the alloy is to heat treatment and consequently the less pronounced will be this brittle range. By employing a fully austinitic chrome nickel alloy, heat treatment has no effect, except to relieve cold working strains, and no brittle range develops. In Fig. 2, is shown graphically the nickel chrome compositions giving base metals thoroughly suitable for welding. In alloys of over 17% chromium, the brittle range is not pronounced. In some applications the brittle range is of no consequence.

The scope of this article is confined to a description of stainless steels from the standpoint of using them in welded articles of manufacture. It is intended to be a sort of primer to help get started in the matter of redesigning many articles now made of other metals. In a later article will be given full description of the welding rods, equipment, technique and cost data for both welding and cutting stainless steels as the processes have been developed by the Fusion Welding Corporation, Chicago.

APPENDIX

Analyses of Various Brands of Stainless Steels

The following compilation of the analyses of many brands of stainless steels has been prepared for convenient reference. It is as complete as could be made from available data, and covers so many of the well known brands that it will be useful reference material.

BRAND	CHROMIUM	CARBON	NICKEL
VASCO	14	.33 to .35	
VASCO CROCAR STEEL	14	2.25	
Vanadium Alloys Steel Co., Latrobe, Pa.			
ASCOLOY 33	12 to 16	.12 max.	.50 max.
ASCOLOY 22	17 to 20	.20 max.	7 to 10
Allegheny Steel Co., Brackenridge, Pa.			
JESSOP STA-GLOS	Made to various analyses		
JESSOP DURO-GLOS	High	Low	
JESSOP HI-GLOS	High	Low	High
Jessop Steel Co., Washington, Pa.			
SWEETALOY 16	18		
SWEETALOY 17	18		8
SWEETALOY 18	22		8
SWEETALOY 19	28		
M. J. Sweet Foundry Co., Irvington, N. J.			
AGATHON ENDURO A	17	below .10	under .25
Manganese, under .50; Silicon, .50 to 1.25.			
AGATHON ENDURO S	13	.05 to .12	under .25
Manganese, under .50; Silicon, under .50.			
AGATHON ENDURO S-15	13	.12 to .18	.50 min.
Manganese, under .50; Silicon, under .50.			
AGATHON ENDURO S-188	18	very low	8
Manganese, under .50; Silicon, under .50.			
Central Alloy Steel Corporation, Massillon, Ohio.			
BRILLIUM	12 to 14	.30 to .40	
Manganese, .30 to .40; Silicon, .25 to .35.			
RESCOR-1	11.5 to 13	.12 max.	
Manganese, .35 max.; Silicon, .40 max.			
RESCOR-9	16.5 to 18	.85 to 1	
Manganese, .40 max.; Silicon, .40 max.			
Atlas Steel Corp., Dunkirk, N. Y.			
DURALOY A	27to 30	.20	
DURALOY B	16 to 19	.09 max.	
DURALOY C	12.5 to 14	.09 max.	
DURALOY N	21	very low	12
Duraloy Company, Pittsburgh, Pa.			
MIDVALE STAINLESS A	9 to 16	high	
MIDVALE STAINLESS B	over or under A	.30 to .40	
MIDVALE STAINLESS C	11 to 15	under .12	
Midvale Company, Nicetown, Pa.			
No. 830	13 to 14	.25 to .35	
Manganese, .20 to .40; Silicon, .25 to .35.			
No. 831	16 to 17	.50 to .60	
Manganese, .20 to .40; Silicon, .25 to .35.			
No. 840	12 to 14	.12 max.	
Manganese, .40 max.; Silicon, .40 max.			
Henry Disston & Sons, Inc., Philadelphia, Pa.			

The following alloys, though not coming under the classification of "stainless steels," are often considered along with them, in studying their characteristics from the welding standpoint. These heat-resisting or corrosion-resisting alloys, mostly non-ferrous, require particular attention to welding technic in each individual case, on account of the wide, variations in the chemical analyses. The correct welding procedure has already been developed successfully for a number of these alloys. They are not, however, included in the above discussion of stainless steels.

BRAND	IRON	NICKEL	COPPER	OTHER METALS
MONEL METAL	.....	67.00	28.00	5.00
The International Nickel Company, New York City.				
				Manganese
MOND "SEVENTY"	1.12	70.00	26.00	3.25
American Mond Nickel Co., Clearfield, Pa.				
				Chromium
NICHROME	.....	60.00		12.00
Balance, Iron, Carbon, Manganese.				
Driver-Harris Company, Harrison, New Jersey.				
				Silicon
DURIRON	84.75	.....	.....	14.25
				Aluminum
ALCUMITE	3.50	.....	87.50	7.50
Balance nickel or chromium				
Duriron Company, Dayton, Ohio.				

THIRD ANNUAL CONFERENCE ON WELDING AT PURDUE UNIVERSITY

A year of interesting progress in the investigation and application of the different welding processes was reviewed at the Welding Conference held at Purdue University, Lafayette, Ind., December 13, 14 and 15. The splendid pioneer work done by this university in initiating and developing the conference plan for plant executives interested in welding has had the effect of bringing more research work to bear on welding problems at that school, and also has set an example which other engineering schools have recently followed. The welding industry cannot fail to benefit from such activities. However, these group meetings have been held largely for the benefit of industrial plants in the State of Indiana, and the representatives of these plants have not been hesitant about acknowledging the value of the conferences to them. Some have shown their appreciation by attending every one of the three annual meetings, and others have brought back stories of improvements in their own work resulting from attendance at the lectures and demonstrations.

The attendance at the recent conference was practically the same as in previous years, with the same noticeable concentration of interest. The program in general covered the following phases of welding; the effect of welding rod characteristics on welding operations; mechanical helps which lead to better results in production welding; how research is improving Thermit welding practice; what engineering data are available concerning gas welding; operating principles which lead to economies in gas cutting; progress in pipe welding, production welding, structural steel welding, and the replacement of castings by welded structural steel shapes; the need for pure research in welding; the development of stronger joints in bronze welding cast iron.

Several of the papers presented at the conference will be reproduced in *The Welding Engineer*. Those who attended have been asked to keep the next conference in mind and send in suggestions for future papers and discussions, so that they may be as useful as possible to all who come for the purpose of getting information.

This report is necessarily brief because of the closeness of the conference dates with the date of publication of this issue. It would, however, be very incomplete without mention of the fine hospitality extended to all visitors by the officials of Purdue University, and the efficient management of the program. Professor W. A. Knapp, of the Engineering Extension Department, and Professor J. D. Hoffman, head of the Department of Practical Mechanics, have been especially active in the management of these affairs and deserve a corresponding measure of appreciation for their unsparing efforts.

Convention Shows Value of Research

Technical Papers Presented Before I. A. A. Point to Progress Reached Through Scientific Studies—Morehead Medal Awarded to Underwriters' Laboratories

AT THE Friday afternoon session of the Annual Meeting of the International Acetylene Association, held at the Stevens Hotel, Chicago, November 16th, 17th and 18th, Dana Pierce, President of the Underwriters' Laboratories, Inc., accepted for his organization the Morehead Gold Medal, the Association's annual award for exceptionally meritorious service in the production and utilization of calcium carbide and acetylene.

In presenting the medal R. A. Sossong, Past President of the International Acetylene Association, paid a glowing tribute to the Underwriters' Laboratories as an organization and to a number of individuals at present or in the past connected with the Laboratories who have contributed to the safety and standardization of the various apparatus in which acetylene is used and made.

Left, L. E. Ogden, Oxweld Acetylene Company, President, 1927-1928; Center, A. Cressy Morrison, New York, Secretary-Treasurer; Right, W. A. Slack, Torchweld Equipment Company, Chicago, Retiring President.

The meetings were presided over by W. A. Slack, Chicago, President of the Association. The Officers elected for the year 1927-1928 were President, L. E. Ogden, Oxweld Acetylene Company, New York; Vice-President, L. F. Loutrel, Shawinigan Products Corporation, New York; Secretary-Treasurer, A. Cressy Morrison, New York. Directors, W. A. Slack, Torchweld Equipment Company, Chicago; E. L. Davis, Cleveland; H. S. Smith, Union Carbide Company, New York; H. S. Pearson, Burdett Oxygen Company, Chicago; and W. C. Keeley, Jr., National Carbide Company, New York; in addition to J. A. Johnson, Johnson Acetylene Co., Crawfordsville, Ind.; W. D. Flannery, K-G Welding Co., New York; R. A. Sossong, Air Reduction Sales Co., New York; and C. A. McCune, Page Steel & Wire Co., Bridgeport, Conn., elected in 1925 and 1926.

An address of welcome to Chicago was made by Samuel M. Hastings of the Illinois Manufacturers Association, and Prof. H. B. Lemon, University of Chicago, discussed some important phases of modern research in the keynote address.

At the technical sessions an important series of papers was presented. Dr. H. L. Whittemore, Bureau of Standards, Washington, D. C., outlined the testing work on welded specimens conducted by the Bureau of Standards and described a series of tests on welded pressure vessels and welded structural steel which the Bureau will undertake at an early date.

The subject of the relative efficiency of city gas and acetylene as fuel gas for cutting with oxygen was also discussed in two important papers. J. K. Mabbs, Union Carbide Sales Company, New York, showed by a conclusive series of laboratory tests that the theoretical efficiency and the efficiency in practice for city gas as compared with acetylene was in the favor of acetylene even on clean steel, and that as the thickness of the metal increases or consideration is given to metal coated with oxide, rust, paint or other foreign material, high preheating speed gives an important advantage to acetylene. In a paper which followed, written by J. L. Anderson and read by E. R. Luddington of the National Carbide Company, New York, a description of an extensive series of shop investigations seemed to confirm conclusively the deductions put forth by Mr. Mabbs. Mr. Anderson's paper cited a large number of instances where industrial organizations had found by practical use in the shop that even with city gas available at the point of consumption acetylene proved more economical, considering time, speed and extra oxygen cost.

The welding of large pressure vessels from 1⅛-inch steel plate was described in detail by H. E. Rockefeller, The Linde Air Products Company, New York. Mr. Rockefeller stressed the necessity for procedure control in work of this kind and outlined the stringent tests to which a number of pressure vessels built under his supervision were subjected. A major point in Mr. Rockefeller's paper was that welded pressure vessels made under procedure control are put into service with the known factor of safety of three, the pressure tanks described having been tested to the point just below the yield

point of the metal. This test, which was described in detail in Mr. Rockefeller's paper, was contrasted with the design factor of safety required by most regulations covering pressure vessel construction. R. M. Mock, New York, Technical Editor of "Aviation," described welded construction of aircraft.

W. B. Miller, Union Carbide & Carbon Research Laboratories, Inc., Long Island City, N. Y., in a paper on the "Mechanical Testing of Welds," described several new methods of testing welded specimens and welded structures and outlined some considerations for interpreting these tests. Mr. Miller showed that an important adaptation of the bend test for welded specimens was a method for measuring the stretch in the outside fibers of the bended specimens at the point where the first fracture appears. W. H. Dreis, Dreis & Krump Manufacturing Co., Chicago, outlined methods employed by his organization in producing machine tools with bases and other parts fabri-

The James Turner Morehead Metal.

cated by cutting and welding standard plate and shapes. "This method of construction," said Mr. Dreis, "not only makes possible production of equipment at lower prices, but also gives the user almost accident-free apparatus by eliminating gray iron almost entirely in the construction of machine tools."

T. W. Greene, New York, described the "Shear-Vee Joint for Bronze Welding Cast Iron Pipe." This new development in pipe jointing promises to eliminate entirely all of the disadvantages of cast iron pipe with respect to tightness and permanency of joints, and a long series of tests in the laboratory and in the field seem to indicate that by the method outlined, and with the proper weld design, a bronze welded joint up to the full rated strength of the pipe itself can readily be produced. Mr. W. A. Lacke, master mechanic, Pullman Company, Chicago, described welding of their products in the Pullman shops and told in detail how the oxy-acetylene process was used in the construction of cars built by the Pullman Company.

Committee reports and the report of the Association's consulting engineer, J. I. Banash, Chicago, indicated substantial progress in the Association's field of activities for the past year. At the annual banquet held Friday night, November 18th, the speakers were the retiring President W. A. Slack; Incoming President L. E. Ogden; Prof. H. B. Lemon, University of Chicago; Prof. Gerald Wendt, Pennsylvania State College; Dr. A. D. Risteen, Travelers Insurance Company, Hartford, Conn.; Dana Pierce, Underwriters' Laboratories, Inc., Chicago; and John Motley Morehead, New York City.

X-RAY SERVICE FOR METAL INDUSTRIES

Herbert R. Isenburger, Inc., successor to Bondi & Isenburger, Inc., 63 Park Row, New York City, have announced the establishment of an X-Ray service for fault analysis. Arrangements have been made with Ancel St. John, Ph. D., well known authority as consulting physicist for industrial uses of X-Rays, who will supervise all laboratory investigations and also consult on X-Ray installations.

ARC WELDING TANK SEAMS AT HIGH SPEEDS

By Robert E. Kinkead

Constant increase in speed of welding tank seams on the part of tank manufacturers has opened up the whole question of what ultimate speeds will be reached.

The matter has a direct bearing on the selling price of tanks. An instance of this occurred several years ago when a Western Pennsyvania tank builder suddenly doubled the speed of welding of his product and was able to deliver tanks in Boston profitably at a price below the price at which the tanks could be made in Boston.

Many tank builders have looked on increasing welding speed as merely a labor saving. Thus if a tank could be welded in four hours instead of eight hours. with labor at 70 cents per hour, the tank builder would figure that he had saved about $2.80 on the job. This is a bad underestimate of the saving. With overhead on direct labor at 150 percent, there is an additional saving of $4.20. Increased speed of welding also means greater output for the same space. Increased welding speed with these tangible savings means price concessions to get more business without killing the profit.

Until recently it was believed that higher welding speeds by using larger welding rods and more welding current would "burn" the metal. The fact is that higher currents and larger rods do not burn the metal any worse than the low currents and small rods.

The physical properties as shown by test of the metal deposited at comparatively high currents are materially improved instead of spoiled. This is perhaps due to a considerable extent to the fact that it is easier to get good fusion with high currents than it is at low currents. The following physical tests by E. V. Kesinger of the Empire Companies of Bartlesville, Oklahoma, indicate the facts rather clearly. Both average and maximum strength of the welds was increased in going from 120-160 amperes to 200 amperes.

No one knows at the present time what the ultimate speed of metal electrode arc welding may be. One-half inch thick tank steel has been welded manually at the of 30 feet per hour. The work is done without beveling the plates. Penetration half way through is made from each side using 3/16-inch diameter rod and 700 amperes. This means a speed on each side of 60 feet per hour.

There is reason to believe that 60 feet per hour is not the ultimate speed at which the arc may be advanced with penetration 1/4-deep between two plates being welded. In the first place no 3/16-inch diameter welding rod has been available which is particularly well suited to metal electrode welding. A stable-arc welding rod in large diameters has recently been offered on the market. Secondly, known methods of electrostatic arc control have not been applied to high current speed welding with the metal electrode process.

Limitations of Equipment.

Commercially, one of the obstacles to higher speeds of welding comes from the fact that existing welding equipment in the shop is not large enough to furnish the heavy currents required for the work. The general tendency in the purchase of welding equipment is the same as in many other lines of equipment. A man buys about the same size equipment he finds other people using in the same line of business. Yet, owing to the rapid developent of arc welding in the direction of using higher currents, it would seem wise to provide ample capacity for future development. A case illustrating the point is that of installing a 200 ampere or 250 ampere arc welding unit for tank shop welding. Three hundred and four hundred ampere equipment for each operator is already being used by tank shops with substantial reductions in cost of welding.

Higher speed welding is being done because economic forces are at work making it necessary to do welding at steadily decreasing costs. Large welding outfits are being installed because they are necessary if high speed high current welding is to be done.

SUMMARY OF WELDING TESTS—DRUMRIGHT 16-INCH LINE

	Elect. weld. No. 18 gage rod. 125-160 amperes 4 specimens	Elect. weld. No. 14 gage rod. 125-160 amperes 4 specimens	Elect. weld. No. 14 gage rod. 175 amperes 12 specimens	Elect. weld. No. 14 gage rod. 200 amperes 16 specimens
Tensile strength, ave.	35,507	42,430	44,745	45,514
Tensile strength max.	40,650	46,240	52,320	51,820
Tensile strength, min.	35,410	41,030	36,600	33,560
Yield point, ave.	26,957	27,385	36,887	35,327
Yield point, max.	29,270	28,870	39,190	43,460
Yield point, min.	25,680	26,770	32,370	27,170
Elongation in 8 in., ave.	0.23	0.45	0.23	0.64
Elongation in 8 in. max.	0.42	0.65	0.68	1.69
Elongation in 8 in. min.	0.12	0.41	0.16	0.04

BRONZE JOINT OF GREATER STRENGTH

(*Continued from page* 33)

Inspection of joints in service over a period of four years and investigations conducted and reported by the Committee of Corrosion of the American Gas Association and U. S. Bureau of Standards have shown that the rate of corrosion is no greater in or adjacent to the joint than in any other part of the pipe.

With the strains minimized and with a joint that actually approximates the strength of the pipe, success is assured for the leakproof, long-lived installation that bronze welded cast iron pipe construction offers.

Summary

In conclusion, this investigation and test of bronze welded joints in full size members, have established the following facts:

(1) The bronze welded collar joint for cast iron pipe is inefficient.

(2) The weakness of the joint and the characteristic failure that occurs in the cast iron next to the bronze collar, is not, as has sometimes been contended, due to shrinkage of the bronze collar, structural change, or any detrimetnal effect on the cast iron from heat or the bronze-welding process. The weakness is in mechanical design and is the result of a very high stress concentration adjacent to the collar.

(3) The bronze-welded vee joint is from 50 per cent to 100 per cent stronger than the collar joint. The strength of the vee joint, although not exactly equal to that of the pipe, approximates it. Searing or annealing the machined bevel is necessary to insure a strong positive union between the bronze and cast iron.

(4) The shear-vee joint by adding a shear area to the strong vee joint develops practically the full strength of the pipe.

(5) The vee type joints in addition to being stronger, require less materials, are more easily and quickly made and are hence cheaper than the collar joint. They compare favorably in cost with any of the common mechanical joints in use which do not have the absolutely leakproof, non-deteriorating qualities offered by the bronze welded joint for cast iron pipe.

(6) Under ordinary conditions the use of these joints combined with reasonable care and thought in laying and placing expansion joints, guarantees the elimination of failures in a bronze-welded cast iron pipe line.

C. G. M. A. ANNUAL DINNER

Announcement has been received that the Fifteenth Annual Dinner of the Compressed Gas Manufacturers' Association will be held at the Hotel Astor, Times Square, New York City, Monday evening, January 23rd. Mr. F. R. Fetherston, secretary of the association, states that arrangements are under way to make this an anniversary of distinction, with everything planned on a larger scale than ever before.

AUSTRALIAN RAILROAD BRIDGE STRENGTHENED BY WELDING

The photographs show the Echuca Bridge on the Moama to Balranald railway, Australia, strengthened to take heavier locomotives by welding. The bridge carries road and railway traffic, and is constructed of wrought iron plate girders supported on cast iron cylindrical piers. There are seven continuous deck plate girder spans of 48 feet one side of the river, three continuous through plate girder spans, 98 feet, 12 feet, 98 feet, over the river, and 17 approach spans of 48 feet on the other side, making a total length between abutments of 1,452 feet. The floor system required strengthening; to do this by riveting would have involved much interference with both the work and the traffic, whilst certain highly stressed rivets could not be relieved by ordinary methods except by renewal of the whole deck system, the cost of which would have been prohibitive. By welding, however, the work was considerably simplified, and all the existing deck

General View of Echuca Bridge

system retained. On the cross girders the flanges were welded to the webs, and the web splices were welded where the rivets were overstressed. The piers and the end connections of the stringers were repaired, also additional bracing was welded into the girders. An extra top flange plate was welded to the cross girders, the existing rivets being countersunk. The transoms and rail deck were lifted about an inch, the top of the cross girder scraped clean, and the extra plate was slipped into position. This plate was one inch wider than the existing flange plate to allow for an overhead fillet weld. Two angles, 3 inches by 3½ inches were clamped on the bottom flange and welded into position outside the outer row of rivets with the vertical flange on the outside and turned down thus leaving the existing rivets accessible.

Before carrying out the welding the dead load stresses were relieved by trussing up each cross girder as shown. A wire rope was passed round two single blocks hooked to the main girder, the slack was taken out of the rope by means of a union screw and the cross girder was forced up by the use of a jack as a kingpost. Two sets of gear were used so that while one cross girder was being welded the next cross girder was being prepared for the welders. This method is convenient to apply as it does not obstruct the welding, and has the advantage that in the event of the passage of a train during welding operations the cross girder still carries the live load, there being sufficient elasticity in the wire rope to allow the cross girder to deflect. The completed welding on the webs of the cross girders and the end connections of the stringers can be seen in cross girder No. 28, and in the cross girder in the foreground; the welding along the angle can also be seen. The slag had been cleaned off the weld, and although the photograph has not been retouched, the bright surface of the welds shows up by reflected light. Two welders are

seen in the photograph, one to each half cross girder. Alternating current was supplied by the State Electricity Commission from the temporary power station at Echuca. Although originally built

Welding Operators at Work. (Note the Welds on Girder Marked 28.)

for engines of 58 to 62 tons, this bridge has been tested recently, after reconstruction by welding with Quasi-Arc Electrodes, by passing over it a 128-ton locomotive, and under this test gave every satisfaction. The work was carried out by the railway construction branch of the Victorian Railway under the direction of Mr. C. H. Perrin, M.I.E., Aust., Chief Engineer.

INCREASED INTEREST SHOWN IN WELDING AND WELDED PRODUCTS AT POWER SHOW

The Sixth National Exposition of Power and Mechanical Engineering, held at the Grand Central Palace, New York, December 5th to 10th, contained 530 exhibits, including displays of welding equipment and supplies; boilers, stokers, furnaces, super-heaters, valves and other accessory devices essential to the economical generation of steam; heating and ventilating equipment, refrigeration machinery, power transmission devices, machine tools, woodworking machines and instruments for measuring and recording time, pressure, volume, gas and air flow, temperature, etc.

A large gain was recorded over the previous Power Show in the number of products on displays in which welding played an important part in the manufacture.

Decidedly greater interest in welding was displayed by the visitors and the exhibits of welding equipment were favored with a substantially larger attendance.

Among the exhibits of welding equipment and supplies, were those of American Brass Company, makers of Tobin bronze welding rods; Keith Dunham Co., and Pipe Bending Process Co., showing circular pipe bends made from straight lengths of pipe and also exhibit of assemblies made with welded bends; General Electric Company, with atomic hydrogen welder in operation, demonstrating the welding of various alloys and non-ferrous metals; Lincoln Electric Company, exhibiting Linc-Weld motor operating while totally submerged in a glass tank filled with water, and also demonstrating operation of the Lincoln Stable-Arc welder; Linde Air Products Co., and Oxweld Acetylene Co., exhibiting oxwelding and cutting apparatus, Linde oxygen, Prest-O-Lite dissolved acetylene and Union Carbide; Moto-Meter Company, exhibiting Natweld Gauges, manufactured by the National Gauge and Equipment Company division; Quasi-Arc., Inc., exhibiting welding rods and welding equipment, examples of applications, test pieces and photographs, and also a tank, 24x62x¾ inches, welded with Quasi-Arc electrodes, tested by Pittsburgh Testing Laboratory with alternating fatiguing pressures varying from 0 to 3250 lbs. per square inch, bursting pressure 3600 lbs. per square inch; Torchweld Equipment Company, exhibiting gas welding and cutting apparatus; Welding Engineer Publishing Company, exhibiting The Welding Engineer and the Welding Encyclopedia; and the Acetylene Journal.

MOTOR TROUBLES REDUCED TO A MINIMUM BY WELDING ROTOR BARS TO END RINGS

A correspondent to Power offers the following suggestion to engineers having difficulty with loose rotor bars on induction motors:

I have been much interested in the numerous articles that have appeared in Power on motor troubles of various kinds, and in view of the large number of old-style motors that are still in use I thought some of my own experience along that line might be of interest.

For about 15 years I have had charge of a group of 25 induction motors raging in sizes up to 30 hp., and for several years our chief trouble was loose rotor bars with consequent low speed and overheating. We cleaned and soldered and tightened the short-circuiting rings and rotor bars, but they would not stay put.

About five years ago I saw an advertisement in Power featuring a rotor in which the rings and bars were punched in one piece out of a solid copper sheet and bent into the rotor lamination slots. I took a hint from that advertisement and had the rotor taken out of one of our most troublesome motors and had the rings an bars oxyacetylene welded into a solid squirrel cage. That worked so well that I soon followed with all my other offenders, and since that time I have not had a single rotor failure. Nothing that we have ever done in the line of motor repair has given us so much real satisfaction. The bolts and nuts of the rings and bars were simply melted into a solid piece. R. Manly Orr.

Vancouver, B. C.

SWOPE FINDS 1928 OUTLOOK FAVORABLE

The following is a statement by Gerard Swope, president of the General Electric Company, reviewing business conditions for the past year and commenting on the outlook for 1928:

"The electrical manufacturing business for 1927 has, on the whole, been satisfactory, and about the same in volume as the previous year. The use of electric current in homes and factories has increased 7 percent over 1926, and with the exception of 1921 has shown an increase each year since 1919 when the index was first prepared, and the consumption in 1927 was more than double what it was in 1919. This is becoming one of the best indices of general and industrial conditions in America.

"The outlook for 1928, is on the hole, favorable. Economic conditions are sound and the satisfaction of the demand of 120,000,000 people should provide ample business activities with the usual attendant improvement in the art. Earnings of labor have never been so high and with a continuance of good business their earnings should continue and employment become steadier."

WELDING AND RIVETING*

Discussion of structural welding at the American Welding Society meeting at Detroit last week gave fresh evidence of the continued and increasing liveness of interest in this new art. Serious attention to its details on the part of structural men is only a year or two old, although brilliantly successful pioneer work dates considerably farther back. Welding, therefore, has been in the position of an unproven pioneer method, seeking introduction into a field where admirable and thoroughly dependable methods already exist—an undertaking of obvious difficulty. Yet consistent extension of welding to new types of structural work has been made from month to month in the past few years, and progress continues along the same lines with increasing momentum.

What the utlimate end of this development is to be cannot yet be foretold. This much has been made certain by now, however: There is no room to doubt that welding will stay in the structural field, and that it will have to be reckoned with permanently as part of the working equipment of the art.

A note sounded in the Detroit meeting by Joseph Matte, well known Detroit engineer, is significant in its application to the future of welding. He summarized his experience in applying welding to a large range of structural forms by the conclusion that welding will be found preferable to riveting in all cases where it offers some inherent advantage that is of value in the particular application proposed. Instances are: Where joints must be tight; where maximum rigidity is sought: where it is desired to make ana attachment to one side of a structural member without having access to the other side. These, of course, are illustrative cases only, and no doubt many others will develop as the actual use of welding is further extended.

Almost simultaneous with the meeting noted, there was a new instance of agitation against the noise of riveting hammer in city residential areas. We have previously noted earlier discussions of this subject. On the present occasion, an influential association of the property owners along a street of costly residences and apartments in New York City made public protest against the ceaseless daily din of riveting hammers and other construction tools, and asked the city authorities whether they could not eliminate or reduce the peace-destroying noise by regulation. One can easily appreciate their attitude, for even a day spent in proximity to a building operation where riveting is in process is a sore trial, and a month of it could make life seem hardly worth while. Yet in those progressive regions of a large city where active development of new buildings is in progress, the metallic drumming of the riveting hammer, near or far, is hardly ever silent. Welding presents the opportunity of eliminating the noise, and in this fact may lie one of the inherent advantages to which Mr. Matte referred. Even in the face of greater difficulty and cost, it may succeed in largely displacing riveting on city work because of its freedom from noise. When the public and its governmental authorities become less tolerant of noise than they are now, it is not inconceivable that they might prohibit riveting as an unwarranted breach of the peace, or so seriously restrict its use as to put it out of the running.

It is proper to bear in mind, however, that the remark quoted has wider application than to the question of welding. Every new method, process or device has to overcome the opposition of that which exists and which it would replace. It must overcome the initial handicap of question as to efficiency, dependability or cost, but in its very nature it will also possess characteristics and advantages which the older method does not possess. The natural development of its field of application rests on proper use of these inherent advantages of the new method. The whole art is enriched by the innovation, and the ultimate relation of the new and the old is likely to be found in their suppelmenting each other rather than in competing. Just as a new transportation facility, competing with an existing one, largely creates its own traffic and supplements rather than destroys the old facility, so a new technical method usually develops those uses and benefits arising out of its own characteristics and makes the resources of the art so much greater. So the ultimate place of welding in the structural field may prove to depend upon the new character of its service rather than on competition with riveting, and the two processes may co-exist and co-operate, to the general advancement of the structural art.

**An editorial in a recent issue of The Engineering News Record.*

NON-FERROUS METAL ARC WELDING

Process of Welding Copper, Brass Monel, Bronze Nickel, Aluminum and Machinable Cast Iron Welds

By Alexander Churchward*

THERE is considerable doubt in the minds of the welding industry in general concerning welding with and upon non-ferrous metals. We might even safely say that the majority of men connected with the welding industry state positively that "It can't be done" when the question of welding copper, brass, bronze, aluminum and procuring machinable welds in cast iron is brought up. This we believe due to the fact that a sufficient study has not been made of the subject. With that in view we wish to advise that:

Non-ferrous electrodes, nickel, brass, bronze, aluminum and monel do not act the same as good ferrous electrodes.

The ability of an electrode to do overhead or vertical welding depends on the globular formation of the electrode material when passing through the arc. (The globular formation referred to is the small amount of molten metal in the form of a drop or globule that forms at the end of an electrode after the arc has been struck and is projected through the arc into the weld.)

The globular formation of a good steel electrode when used with the right value of current for its cross-sectional area and a short arc, will be very rapid, from 35 to 50 per second, and as the amount of deposited metal is practically fixed for any given current, the size of the globule will be very small and therefore the combined force of the occluded gases (occluded gases are those which are in the electrode material inert, when cold, but under the heat generated by the arc they expand and force the molten globule away from the end of the electrode) and capillary attraction will allow good overhead welding to be done, because the globule is literally shot overhead and attracted by the parent metal.

If a long arc is used the globular formation will be comparatively slow and the globules of such a large size that it will be impossible to cause any appreciable amount of metal to go overhead. Although the speed of fusion of electrode material will be approximately the same as with the short arc, owing to the increased size of the globule, the occluded gas will not have the same driving force and as the length of arc is greater very little capillary attraction will take place. The result will be that when attempting overhead welding with a long arc most of the fused electrode will go on the floor.

A good steel electrode melts from the inside out, the outside surface must be more refractory than the metal inside. This is accomplished by certain finishes and coating put on the electrode for this definite purpose.

All the above can be readily observed by the use of a photographic lens in a dark room, projecting the arc on a screen.

A non-ferrous electrode, copper, bronze, aluminum or monel metal, acts the same way as a steel electrode with a long arc.

But as the deposition of the non-ferrous electrode in pounds per hour is much greater than the steel electrode, it is at once evident that the globular formation of the long arc referred to above is much larger. In fact it is at the rate of 3 to 5 per second, against 35 to 50 with ferrous electrodes. Therefore it can at once be seen that the globules are very large. Because of this condition (very large globular formation) it is impossible to weld overhead or even vertically with non-ferrous electrodes.

Iron and steel are relatively poor conductors of both electricity and heat, while copper, bronze, etc., are good conductors of electricity and therefore of heat.

Due to the high heat conductivity of non-ferrous electrodes it has been found necessary to use reversed polarity, positive

**Technical Director, Wilson Welder & Metals Co.*

at the electrode, as most authorities agree that approximately 75 per cent of the heat of the arc is at the positive terminal and approximately 25 per cent at the negative terminal. It may be well to point out here that a good conductor of electricity is also a good conductor of heat, (a good conductor being one that has a comparatively low resistance.)

As the work therefore will be negative, approximately only 25 per cent of the heat of the arc will be available to heat the work up.

Therefore when welding copper, bronze, etc., it becomes necessary to preheat the work up to the point that the molten electrode metal will amalgamate with the work (parent metal). If the cross-section of the part to be welded is small, then the preheating can be stopped after the welding commences, providing, however, that the work has been preheated sufficiently, and the heat of the arc will supply the necessary heat to finish the weld. The above is true for any ordinary size sections but when large masses of copper, bronze, etc., are to be welded it may be necessary to continue to heat these large masses, as in these cases the heat is conducted away faster than the arc can supply it.

In other words, to successfully weld copper, bronze, etc., the heat of parent metal must be kept up to the point at which the molten globule from the electrode will fuse in.

It is good practice as each length of electrode is fused down, to hammer the weld and brush same thoroughly before more molten metal is applied. To obtain the necessary heat in the work (or parent metal) before commencing welding, same can be furnished by the carbon arc, blow torch, etc. Be sure to see that the surface is clean before welding.

The above reversal of polarity on non-ferrous electrodes like bronze or monel metal, is not necessary when welding cast iron. Straight polarity, i. e., negative at the electrode, gives the best results. Preheating of cast iron should not be used. In welding cast iron, care has to be taken *not* to heat up the metal surrounding the weld. The welding of cast iron to procure machinable welds, with No. 12 Wilson processed monel metal must proceed slowly so as not to heat up metal surrounding weld. The best practice is to weld one or two inches and then weld in another part, returning to first weld when it is cooled off.

On many large jobs such as engine frames and very large cast iron caustic potash vats, No. 12 would be too costly to use if the entire weld were made with it. For instance on big cast iron work which calls for a machinable weld and which would take a great deal of electrode material, the following method of procedure can be used to good advantage.

After the work has been properly Veed out, cover the cast iron surface to be welded with a single bead of No. 12 carefully peening each bead as it is put on *while hot*, then fill up in the ordinary way with a steel electrode until within approximately 1/8 inch of top of V. Brush thoroughly and proceed to fill up to top of V with No. 12 carefully peening each bead while hot. This will give a machinable cast iron weld on large work at a reasonable cost. The idea of putting a bead of No. 12 on the surface of the cast iron is to prevent the hard non-machinable and brittle line from forming between the weld and the cost iron as No. 12 has the property of absorbing the carbon from the cast iron and to substantially inhibit the formation of a non-machinable brittle area.

The second example is welding up cracks in large cast iron vats which are used to contain corrosive materials.

After the place to be welded is Veed out and thoroughly cleaned, weld up to within approximately 1/8 inch of the top of V with a steel electrode, then fill up with No. 12, carefully peening each bead as it is laid down. This will give a non-corrosive surface to the weld.

The Wilson Welder & Metals Co. furnishes electrodes for non-ferrous welds as follows:

No. 12, for machinable cast iron welds.

No. 20, brass, copper and bronze.

No. 50, general aluminum welding.

Monel Metal No. 12, Wilson Processed for welding monel metal.

Special electrodes for stainless steel, etc.

AN ALL WELDED BOAT

The Toledo Electric Boiler Welders of Toledo, Ohio, believe in taking their own medicine—so when it was decided that two new boats were necessary to carry on their operations, it was natural that they should be all welded. Photographs 1 and 2 show the resulting job.

There are two boats 36 feet in overall length and 10 feet in the beam, with a draft of 12 feet. The frame is made of 1½-inch angle iron and the hull of No. 10 gauge sheet. The ribs are spaced 18 inches apart. Every joint was made by arc welding. The motive power for these boats consists of a 6-cylinder automobile engine mounted on a chassis which is welded to the after deck at a slight angle. The very interesting part is the construction of the paddle wheels which were made by welding plates to a set of ordinary disk wheels on an automobile axle. The protection for the paddle wheels against floating logs, etc., is obtained by the steel braces shown in the photograph.

On each boat is mounted a Lincoln "Stable-Arc" welder manufactured by the Lincoln Electric Company of Cleveland, Ohio.

Shop-Made Boats, All Arc Welded, Built by Welding Company to Carry On Their Operations.

MANY WELDED PARTS ON NEW FORD CAR

According to reports, in the new model of Ford car over 400 parts will be welded—an increase of practically one hundred per cent over the number of welded parts in the previous model.

Electric resistance welding is employed on a large scale, and the large increase in the use of welded parts in the car is no small tribute to this class of welding. It is stated that in every case where welding has been adopted, it has made it possible to decrease the weight without decreasing the strength and to lessen the cost to the manufacture without lessening quality. It has, further, immensely facilitated the accurate and precise adaptation of the proper material for the proper parts.

In the American plant it is expected that over 600 spot and butt welding machines will be employed in the manufacture of the new Ford car.—*Fisher's Machinery Guide.*

PIPE WELDING DISCUSSED AT CLEVELAND

On Thursday evening, November 17th, Mr. H. E. Wetzell of the firm of Smith & Oby Company, Cleveland, Ohio, talked to the Cleveland Section of the American Welding Society on the application of welding as particularly applied to the heating and ventilating systems of buildings. Mr. Wetzell's talk brought out many interesting facts and he spoke of many instances where if welding had not been possible his firm would have been up against it as to "How to get around it." Mr. Wetzell's talk was accompanied by a most interesting set of slides showing his own welded installations on Saint Luke's Hospital and the new Ohio Bell Telephone Company, in Cleveland.

DATE SET FOR G. P. A. CONVENTION

The dates for the fourteenth mid-winter meeting of the Gas Products Association have been set by the committee on arrangements for January 26, 27, 28, 1928. All of the meetings and technical sessions will be held in Room 10, Palmer House, Chicago, Illinois. The program is now being developed and it is expected that complete details regarding the program and arrangements for reservations will be ready for publication in a few weeks. Advance notices indicate that the meetings will be full of interest and that the convention will include the usual theater party and banquet.

NEW FIRM OF CONSULTING WELDING ENGINEERS OPEN OFFICES IN CLEVELAND AND CHICAGO

The Welding Engineering and Construction Company have opened their head office at Room 1810 Union Trust Bldg., Cleveland, in charge of E. W. P. Smith, and a Chicago office at Room 1032 National Life Bldg., in charge of C. E. Glasser. This company is engaged in applying welding as a manufacturing tool in plants using iron and steel in their production, thereby reducing costs through replacing castings with welded steel construction or by replacing riveted with welded fabrication.

CHICAGO SECTION SEES ARC ACTION IN MOVIES

At the regular monthly meeting of the American Welding Society, Chicago Section, December 2nd, J. B. Green, President of the Fusion Welding Corporation, Chicago, showed lantern slides and movies of the flow of metal in metallic arc and oxy-acetylene welding, the scenes being chosen so as to illustrate the effect of the composition and structure of the body of the wire and also the surface. The pictures were accompanied by a lecture explaining the significance of these various characteristics of filler rod and electrode material, and their importance in the design of welding rod.

PNEUMATIC EQUIPMENT USED TO CLEAN PIPE FOR WELDING AND COVERING

Pipe lines laid without protective covering in corrosive soils soon require extensive repairs and replacements. In many localities the soil waters carry such quantities of alkali that pipe laid without a covering becomes a mass of pitted junk in a very few years. During the summer months one large oil company maintains several large crews constantly engaged in making repairs and applying waterproofing to the pipe. A thick, well-reinforced coat of asphalt gives splendid satisfaction in adding to the life of buried pipe lines.

This pipe-line repair work involves five main steps; uncovering the pipe, cleaning it thoroughly, replacing badly pitted joints with new pipe, applying a thick protective cov-

Fig. 1. Caterpillar Tractor, By Means of a Rolling Hatch, Moves a Five-Length Section.

ering of asphaltic materials, and again covering the stretch with its blanket of earth.

Pipe that is to be removed is cut out by acetylene torches. Replaced sections are welded into position; repairing is also effected by welding.

Before the welding process begins and before the pipe is covered with the protective covering of asphaltic materials, the pipe is thoroughly cleaned of all rust and accumulations by a series of pneumatically operated machines shown in Figures 1 and 2.

Compressed air is supplied by two Ingersoll-Rand portable

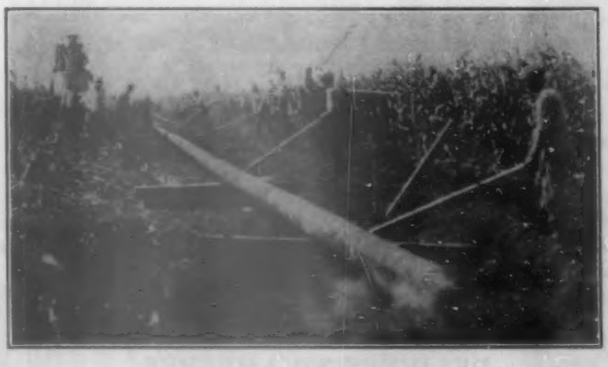
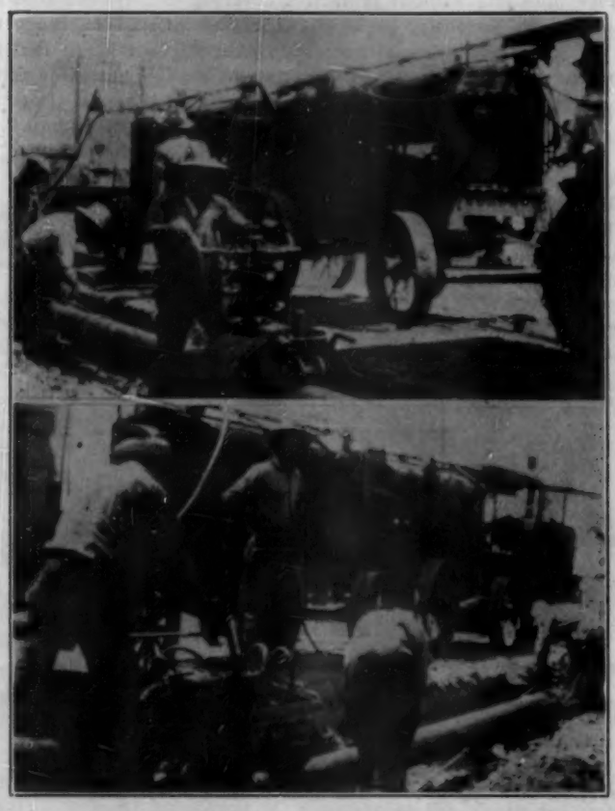


Fig. 2. Tractor Pulling Sections Endwise to Adjust Pipe for Tie-in Joint. Welding Plant on Trailer at Left of Pipe.

compressors mounted on trailers and towed along the pipe line by a "Caterpillar" tractor. The first operation in the cleaning of the pipe in preparation for welding and asphalt covering consists in running the machine over the pipe shown in the foreground. This machine is equipped with a series of "tappers" or hammers which are actuated by compressed air and rapidly strike the pipe, knocking off the rust and other accumulations. Following this is an operator with an ordinary air chipper and following the air chipper is an operator with a machine equipped with air operated brushes which completely clean the entire surface of the pipe ready for welding and covering.

In Figures 3 and 4 are shown the caterpillar tractors which

are used to draw the trailers carrying the welding equipment, and also to bring the pipe into position for welding.



Figs. 3 and 4. Cleaning Pipe with Pneumatic Machinery by Hammering, Chipping, and Brushing.

NEW CATALOG OF TORIT LINE OF BURNERS

The St. Paul Welding & Mfg. Co. has issued a catalog of their kerosene burners, of the hand-pump and the compressed air types, designed for various purposes, such as heating kettles and boilers, drying concrete, sand and gravel, brazing, and preheating in preparation for welding. The tanks are of welded steel with capacities of 1½ to 10 gallons.

TWO NEW MILBURN BULLETINS

The Alexander Milburn Company, Baltimore, Md., are sending out two new bulletins of interest to the welding trade. No. B-200C describes and illustrates acetylene generators in capacities ranging from thirty to five hundred pounds capacity. No. B-200D is devoted to oil burners and preheaters for welding shops, boiler shops, machine shops, railroads, etc. These burners are made in two types, one for use with compressed air, and the other having a hand pump.

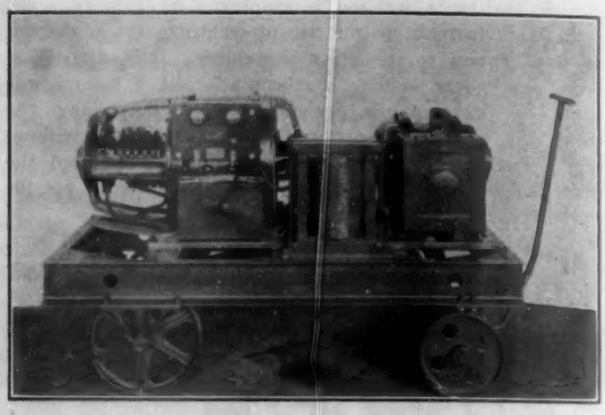
NEW SINGLE-OPERATOR TYPE WELDER DELIVERS 300 AMPERES

A new single-operator welder rated 300 amperes, one hour, 50 degrees C temperature rise is announced by the General Electric Company as the latest addition to its standard line of welding equipment. This machine includes a four-bearing, ball-bearing, motor-generator set with flexible coupling.

With this equipment the manufacturers claim a rapid and simple interchange of motors may be made by the user. As a result inspection, maintenance, renewals and changes caused by changes in the supply circuit would be simplified.

The generator is rated 300 amperes, one hour, 50 degrees C., and the driving motor is a 15-horsepower, 40 degree C. continuous-rated unit. This conforms with the recent ruling of the National Electric Manufacturers Association. The generator is so designed that field control is unnecessary and is eliminated. The generator panel includes an ammeter and a voltmeter, but not the customary field rheostat. The meters used have a metal front except for the glass over the scale, thus minimizing the possibility of breakage.

The motor starters for 60-, 50- and 25-cycle motors are of the enclosed magnetic type, while those for the 25-cycle motors



General Electric Single-Operator Welder

are enclosed resistor starters. The direct-current motors use a simple resistance starter with a line switch. Starting current is maintained in each case well within N. E. L. A. requirements.

The generator is designed to permit belt, motor or engine drive, and will be designed for either stationary or portable use. It can be used as both a manufacturing and a repair tool, for service in foundries, steel mills, locomotive and car shops, ship yards, marine repair yards, tank shops, general machine shops, pulp and paper mills and in any other field where iron or steel is used. It bears the General Electric designation WD-300-A.

NEW TORCHWELD CATALOG

A new catalog of oxy-acetylene apparatus and accessories has just been published by the Torchweld Equipment Company, Chicago, Ill. The booklet is of convenient pocket size, yet sufficiently complete to give a wealth of detailed information regarding the variety and the characteristics of the Torchweld line. Separate torches and regulators are described and illustrated, and complete sets of equipment suitable for different manufacturing requirements are displayed. Line drawings are used to show the construction features of the principal items. Among the new items added to the Torchweld line since the publication of the preceding catalog are the new Style 22NF Welding Torch, interchangeable welding and cutting units, new style cutting torches and cutting units, city gas cutting torches and new style small regulators.

NEWS OF THE WELDING TRADE

Mr. and Mrs. A. F. Jenkins of Baltimore are sailing from New York on Wednesday, December 14th, for a two months' trip to Europe. The Christmas holidays will be spent in England and the balance of the time will be taken up in touring France, Italy and other countries. Mr. Jenkins is President and Treasurer of The Alexander Milburn Company, 1416-1428 West Baltimore Street, Baltimore, Md., one of the oldest manufacturers in the industry.

The Lincoln Electric Company, Cleveland, Ohio, announces the transfer of Mr. E. F. Hoff from the Welder Division at Cleveland to the Welder Division at New York where he will be in charge of Welder Service under the direction of Mr. G. N. Bull, District Manager.

Craftsweld Equipment Corporation, 250 West 54th Street, New York, announces the following addition to their sales and service department: Mr. H. W. Stann, Sales Engineer;

Restored cylinder head of Baldwin type locomotive welded in the Sacramento shops of the Southern Pacific Railroad and returned to service as strong as ever.

The fractured cylinder casing before welding, showing the extent of the break.

Side view of repaired casing. The strength and dependability of Tobin Bronze Welding have made it a standard repair method in many railway shops.

A Fractured Locomotive Cylinder Restored by Tobin Bronze Welding

The remarkable welding job illustrated is a source of pride to the Sacramento Shops of the Southern Pacific Railroad.

Although the front of the cylinder was completely broken off, Tobin Bronze Welding by the oxy-acetylene process returned the locomotive to active service with the least possible delay. Thirty-four man-hours of welding time, and 125 pounds of Tobin Bronze were required. Only four and one-half hours were necessary for pre-heating—an unusually short time for a weld of this size. The engine was repaired in November, 1926, and has been in continuous service ever since; evidence that the original strength of the casting was fully restored.

Because of the low welding temperature required—1650°F.—Tobin Bronze minimizes distortion and metal shrinkage, and makes it possible to keep welded parts in accurate alignment. Except for such large welds as the one illustrated, pre-heating is usually unnecessary when Tobin Bronze rods are used.

Many industrial plants which have proven the value of Tobin Bronze Welding in repair work are now using it to save time and money in manufacturing operations.

Tobin Bronze is made solely by The American Brass Company, and "TOBIN BRONZE" is stamped in every welding rod. They may be obtained from distributors of welding equipment and supplies.

THE AMERICAN BRASS COMPANY
GENERAL OFFICES: WATERBURY, CONNECTICUT
Offices and Agencies in Principal Cities
Canadian Mill: ANACONDA AMERICAN BRASS LIMITED, New Toronto, Ont.

TOBIN BRONZE

REGISTERED U.S. PATENT OFFICE

WELDING RODS

EXCLUSIVELY AN ANACONDA PRODUCT

"STANDARD"
Welding Wire
GAS AND ELECTRIC
A grade for each type of work—send for samples.

for sound permanent welds : : lower costs
Our costs are considerably under those of large industrial centers; ours is a one-profit wire sold direct to user from our own mills exclusively devoted to making of welding wire from raw material to finished product—hence our extremely low prices for wire that is definitely superior. Adopted exclusively by many large users.
Prices on request.
Standard Steel & Wire Co., Greensburg, Pa. (Mills at Bolivar, Pa.)

Mr. William Dann, Jr., Order Department, and Mr. Joseph Stanley, Service and Repair Department.

The regular monthly meeting of the Victorian Institute of Welding Engineers, Australia, held November 24th, took the form of an inspection visit to the welded retort house and coke handling plant of the Metropolitan Gas Company, Melbourne.

The Chicago office of the Gibb Welding Machines Company, Bay City, Mich., recently moved from the Peoples Gas Building to 1768 Pure Oil Building, 35 E. Wacker Drive. C. O. Watson is in charge.

Oxy-acetylene welding of cast iron and aluminum was the subject of discussion at an ordinary meeting of the Institution of Welding Engineers (London), held at the South Wales Institute of Engineers, Cardiff, on November 30th. W. H. Walby was the speaker.

A. G. Odell, head of the department of welding instruction in the Public Opportunity School, Denver, Colo., has been elected President of the Trades and Industrial Section of the Colorado Education Association.

The Los Angeles section of the American Welding Society met December 1st to discuss the regulations which the State of California will adopt for the construction of welded air tanks.

Classified Ads

Help Wanted—75c per line, minimum 4 lines.
Jobs Wanted—4 lines free.
Other Ads—$1.00 per line, minimum 4 lines.
Counted 8 words to line. Add 6 words for keyed address

Position Wanted—For shop, boiler, or construction work, by thoroughly experienced arc welder. Chicago preferred. Address Box 138, care of The Welding Engineer.

Position Wanted—Thoroughly experienced oxy-acetylene welder, graduate of American Trade School, Buffalo, N. Y. Shop and garage experience. Ira M. Phillips, 38 Free St., Fredonia, N. Y.

Position Wanted—By man whose experience dates back to earlier days of welding industry, several years experience as service engineer, but experience is not limited to that acquired in service work. At present employed but wish a change. Would prefer a connection with some engineer specializing in welding engineering and developmental work or some concern desiring to develop their own economies and procedures. Best of references. Address Box 136, care The Welding Engineer.

REBUILT ELECTRIC WELDERS
The following are a few items in our large stock:
200 amp. Lincoln A. C. motor drive
200 amp. Lincoln belt drive
200 amp. Lincoln D. C. motor drive
200 amp. Lincoln gasoline engine drive
Every machine guaranteed
GOODMAN ELECTRIC MACHINERY CO., 126 Green St., Newark, N. J.

Position Wanted—By man who has had 15 years experience at electrical construction and maintenance work. Four years on electric welding equipment, accustomed to handling ten to fifty men and supervising jobs for the past eight years. 33 years of age. With present employer for 10 years. Desire change of location. Address Box 137, care The Welding Engineer.

For Sale—Two Alternarc Welders, 220 volt, 60 cycle, 250 ampere. Both machines practically new. Price, $350.00 each. Wittenmeier Machinery Co., 850 N. Spaulding Ave., Chicago, Ill.

For Sale—200-ampere General Electric welder, direct connected 220-440-550 volt motor, good condition. Address Williams Brothers Company, Custom House Wharf, Portland, Maine.

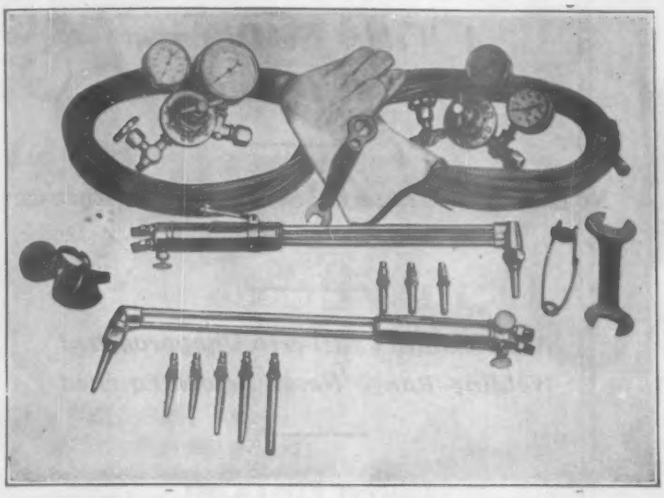
Foreman Wanted—Thoroughly experienced on electric welding. Must be good executive. Give qualifications and salary expected. Address Box 134, care of The Welding Engineer.

Wanted—Welding Service man to cover distributors and trade for well-known manufacturer. Must be experienced in gas and electric welding with some sales ability. Unusual opportunity. State age, experience and salary expected. Write Box 135, The Welding Engineer.

ALEXANDER MILBURN CO.
BALTIMORE, MD.
Have vacancies in 1928 for capable men experienced in Oxy-Acetylene Welding and Cutting Apparatus and Allied Articles, in the following capacities:
SALES EXECUTIVES
capable of handling the business of six or more states
also
DESIGNING ENGINEER
also
SALES CORRESPONDENT
Only men having the largest experience, highest credentials and largest earning capacity desired.

AMERICAN STEEL ENGINEERING COMPANY
10 So. 18 St., Philadelphia
601 Granite Bldg., Pittsburgh

GE Arc Welders, GE Electrodes: TYPES A, B and F
Four Reconditioned General Electric Arc Welders. Price, $300.00 and Up.
Page-Armco Welding Wire and Electrodes
Write to nearest office for descriptive circular and prices



K-G WELDING and Cutting Torches are guaranteed to be free from back-flashing. Simple and scientific construction makes this possible at a reasonable cost. Perfect fitting tips and smooth operation conserve gas and time. A K-G Torch will increase your respect for the oxy-acetylene process.

K-G Construction Is a Big Advantage in Production Welding

This is particularly true when welding long seams, where it is very important to keep an even flow of heat along both sides of the seam. Once started, the welder must carry the weld along to the end in order to get this evenly distributed heat effect. Faulty torches are the most frequent cause of interruptions, so look to your torch. K-G Torches combine accuracy with simplicity, and with these two factors assured the operator can count on continuous performance and good results.

K-G WELDING & CUTTING CO.
515 West 29th St.,
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Distributors in principal cities

K-G

Steel Sales Welding Rods

A Welding Rod for Every Job

Electric ELECWELD Arc

Elecweld, one of our leading rods, is a low carbon rod for electric welding, medium hard, or annealed, furnished Flux Coated when desired. Recommended for wrought iron and steel tanks, boiler plates, angles, sheets, flues, etc., where higher tensile strength is required.

Other rods carried in our Chicago stock for immediate shipment are:

Wilson Color-tipt	E†	Elecweld special	E
Norweld Special	A*	Elecweld	E
Norweld	A	Steelweld	E
Castweld	A	Vanadweld	A&E
Bronzeweld	A	Hicarweld	A&E
Nickelweld	A&E	High Manganese	A&E

*Acetylene †Electric

Write for The Welder's Guide, a Practical Book on Welding

129 S. Jefferson St.
Chicago, Ill.

STEEL SALES CORPORATION

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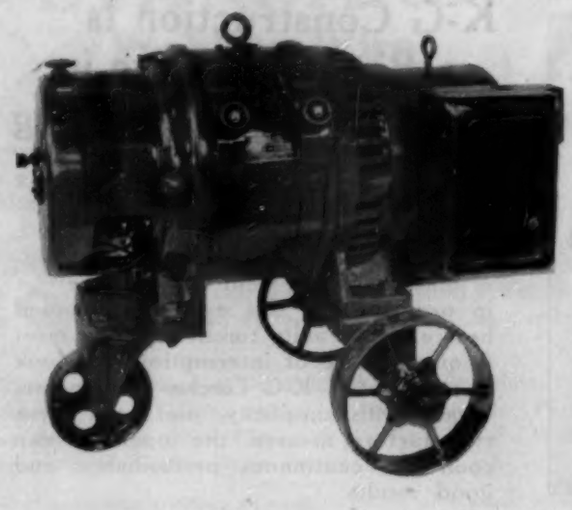
Steel, Monel Metal, Nickel, Brass, Copper, Copperweld, Nickel Silver, Phosphor Bronze, Nickel Zinc.



A Welder So Different
It Merits Investigation

No Exciter—No External Stabilizer—No Rheostat
—One Control—

Arc Flexibility Hitherto Unapproached
Welding Range Never Before Equaled

Lowest First Cost
Lowest Operating Cost

EQUIPMENT-SUPPLIES FUZON WELDING & CUTTING

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Engineers — Manufacturers — Merchants
103RD STREET AND TORRENCE AVENUE, CHICAGO

You Can Do It Better With TORCHWELD

VALUE

Nowhere can you purchase greater dependability, greater freedom from mechanical trouble, greater economy in operation and more durability than Torchweld gives.

Torchweld gas welding and cutting equipment not only is more efficient for your needs, but it represents the most *satisfaction* and *value* for your money.

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Value

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TORCHWELD

The Standard of Comparison

GET THE FACTS. Write for Catalog No. 26.

TORCHWELD EQUIPMENT COMPANY
224 N. Carpenter St. CHICAGO

Uniform Quality Assured

WELDERS who use Commercial Acetylene soon learn that every cylinder contains the same pure gas.

Your torch can tell the difference!

COMMERCIAL ACETYLENE
Means pure acetylene.

COMMERCIAL SERVICE
Means prompt service.

No matter what your gas requirements may be you will be interested in our sales plan. Ask our nearest office to tell you about it.

Supplied in the following size cylinders:

10x30-in. size - - 125 cu. ft. cap.
12x36-in. size - - 225 cu. ft. cap.
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General Office: 71 Broadway
New York City

BRANCHES:

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683 Atlantic Ave. Boston, Mass.
613 Trust Co. of Georgia Bldg. Atlanta, Ga.
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When welds must *last* in service

YOU know Page Welding Wire and Electrodes will give you welds that last in service—for every run of Page Welding Wire is SHOP TESTED.

Another thing—every piece of Page Welding Wire and Electrodes is plainly marked with the name and grade, and each bundle carries a distinctive tag. You are sure of using the right welding material for the job.

There is an abundant stock of Page welding material near you. The Page distributor will be glad to take care of your immediate requirements or help you in selecting the material that will give you best results.

Your name and address will bring you samples. You can prove for yourself the effectiveness of Page Welding rods right in your own shop.

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An Associate Company of the American Chain Company, Inc.
Bridgeport, Connecticut

District Offices: Chicago New York Pittsburgh San Francisco

PAGE-ARMCO PROCESSED Welding Wire *and* Electrodes

When buying CARBIDE — Ask for NATIONAL

BEST for All Industrial Purposes

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IN THE RED DRUM SAVES YOU MONEY

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For UNDERWATER CUTTING
The Ellsberg Torch, Model "S-51"
(Patent Pending)
Using Oxygen, Hydrogen and Compressed Air

Any Thickness — Any Depth
ANYWHERE
Complete Units and Skilled Operators
By the Day or on contract
Prompt Service—Reasonable Rates

CRAFTSWELD EQUIPMENT CORP.
Manufacturers
250 W. 54th St. New York, N. Y.

30% More Welding From Each Tank of Gas, with a

WELDIT GASAVER

GAS consumption stops instantly when torch is placed on hook. Passing the torch tip over pilot light gives same flame adjustment instantly.

No time or gas is lost adjusting flame.

Safety check valve prevents injury to apparatus in case of flashback.

Can be used with all makes of portable and stationary outfits.

Approved by
National Board of Underwriters
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WELDIT — WELDED WITH WELDIT EQUIPMENT AND SUPPLIES

Welding Torches
Cutting Torches
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Lead Burning Equipment
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Cast Iron Rods
Welding Hose
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Fluxes & Solders
Safety Gloves
Service

WELDIT ACETYLENE CO.
634 Bagley Ave. DETROIT, MICH.

Passing Every Test

For Cylinder Safety

In 1910, when the acetylene welding industry was in its infancy, Hackney Cylinders were already being made. At that time, no strict regulations existed.

Two years later, the Bureau of Explosives drew up comprehensive regulations that required all previously made cylinders be subjected to special tests.

Not one Hackney failed to comply with these regulations. Not one has ever failed to comply with later revisions.

During the past 17 years, Hackney Cylinders have been constantly, rapidly improved. Every recommendation of the Bureau has been applied. In many cases, the changes were anticipated, and improvements were made long before the recommendations were received.

In addition, the suggestions of acetylene producers have been used to improve Hackney Cylinders in every possible way.

In short, it has been our aim to produce the safest, strongest, and most economical cylinder possible for the shipment of gas.

That, perhaps, is one reason why 99 7/10% of all the Hackney Cylinders ever made are still in active use.

PRESSED STEEL TANK COMPANY
MILWAUKEE, WISCONSIN
1155 Continental Bank Bldg., Chicago
1331 Vanderbilt Concourse Bldg., N. Y.
5731 Greenfield Ave., Milwaukee

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A Specially Designed Federal Welder for Steel Building Construction

"Safe Welds for Steel Buildings" are made by this specially constructed Federal Spot Welder. It is one of the heavy duty type which has been paying dividends in low-cost production and giving complete satisfaction in a big steel plant in the east.

In this, the world's largest industry, new methods must be constantly developed to speed up production. Federal Spot Welders have proven themselves master performers in this respect, reducing labor costs and, at the same time, turning out vastly larger quantities of material than was possible before their installation. Such results are remarkably satisfactory to any organization.

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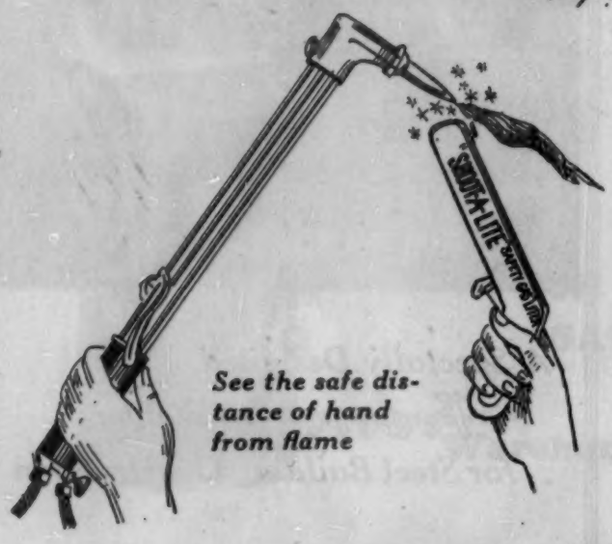
Machine & Welder Co.
Warren, Ohio, U. S. A.

Federal Spot Welders Are Easily Operated and Most Efficient Electrically

-DON'T STRIKE A MATCH-

SHOOT-A-LITE



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SAFE!

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STRONG!!!

The finest torch lighting device ever made. Try it.

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Now in full production with

"KORO"
(Patent applied for)

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Send a trial order for some KORO wire from the new plant.

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WAUKEGAN, ILLINOIS

A complete line of gas and electric welding wire.

MODEL "O"

has been designed to give the welder a maximum of comfort and protection embodied in the extreme lightness of weight, proper ventilation and the absolute exclusion of all outside light.

MODEL "O"

is made throughout of special vulcanized fibre of exceptional strength and wearing qualities. This shield carries the CESCO indorsement; your assurance that the degree of quality and workmanship is of the highest.

Model "O" Handshield

PRICE

Complete with ESSENTIALITE Lens
$5.00 *each.*

Manufactured by

Chicago Eye Shield Company
2300 Warren Ave., Chicago, Ill.

American Steel & Wire Company's

PREMIER

TESTED

WELDING WIRES

PREMIER Welding Wire flows freely, giving perfect fusion, thorough penetration and the desired finish. The uniform quality of Premier Welding Wire insures a deposit of metal in the weld free from foreign inclusions and possessing maximum strength. Before shipment, every bundle is electrically tested and manually welded. Permanently satisfactory welds and a saving of gas, electricity and the welder's time are thereby assured.

For a dependable welding job, use an appropriate grade of Premier Welding Wire. Send for booklet giving full information and specifications.

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Dependability

There is no USL Welder ever built, so far as we know, which is not still in operation.

Add to this the proven operating economy of USL,—its flexibility,—its consistent, dependable performance,— and you can see why USL arc welder sales have increased more than 2800% during the past nine years.

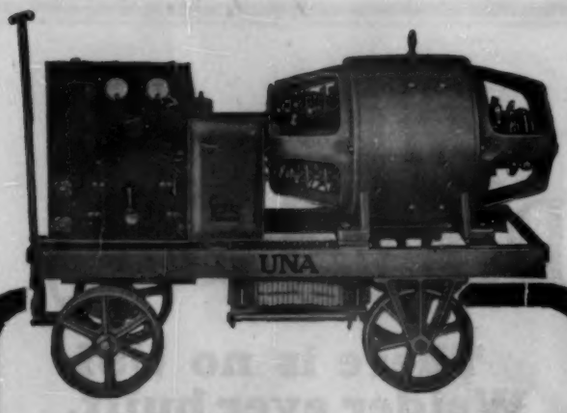
Important Message to Distributors!

The tremendous increase in USL arc welder sales has brought big profits to USL distributors. Get your share of these profits! Write us today for details of the USL distributing proposition.

USL Battery Corporation, Niagara Falls, N. Y.

USL

ELECTRIC ARC WELDER



Plenty of Current

for

Any Welding Job

Una Welders are available in two types:

Type A3..... 75 to 300 amperes
Type A4.....100 to 450 amperes

The type A4 can also be supplied for double operator duty with a welding current range from 60 to 250 amperes for each operator.

The wide range of welding current of Una Welders enables the welding operator to tackle any job from thin steel castings to heavy structural steels and castings.

Una Welding Rods

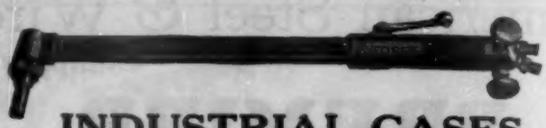
A complete line of bare and coated rods for light and heavy duty welding, for copper, bronze and steel.

Send for Bulletins

Una Welding & Bonding Company

1617 Collamer Ave., Cleveland, Ohio

UNA Welders Welding Rods



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KNOWLES ELECTROLYTIC PLANTS for the production of hydrogen

Knowles Patented Cells are safe, simple, easy to install, automatic, low in first cost and maintenance, and in addition to flexibility of operation have the advantage of producing also a quantity of pure oxygen equal to 50 per cent of the hydrogen volume. Can be furnished in any size up to 15,000 amperes. Total annual hydrogen capacity of plants now in operation, over one and one-half billion cubic feet.

Our experience as American Manufacturers and Distributors enables us to recommend these plants unqualifiedly.

Write for literature and quotation

International Oxygen Company

American Pioneer Manufacturers of Oxygen

I.O.C. SYSTEM

Main Offices: Newark, N. J.
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Your eyes can feel the new comfort behind

WILLSON-WELD GLASS

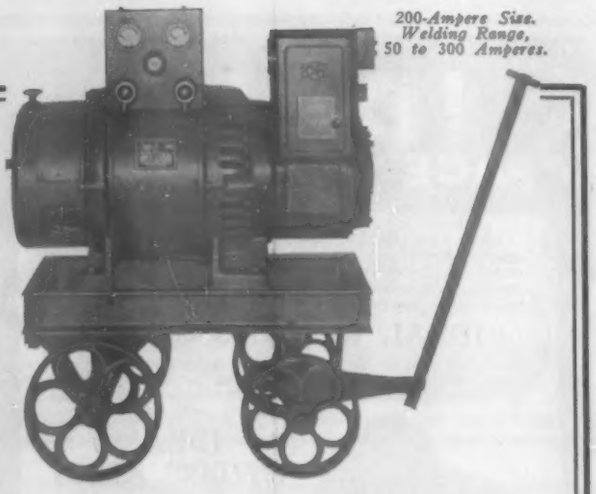
There's greater protection and comfort, more light and vision, when you work with this remarkable welding glass.

Cuts out over 99% of the injurious rays.

Willson Helmet No. 130, equipped with Willson-Weld Glass, $10.20 f. o. b. shipping point. Willson-Weld Glass is also furnished with the Willson Handshield and Willson welding goggles. Ask for complete catalog.

WILLSON GOGGLES, INC.

READING, PA.



200-Ampere Size. Welding Range, 50 to 300 Amperes.

A GOOD WELD IS MADE FASTER with the

Hansen Arc Welder

Because of the ease with which even an amateur can strike and maintain an arc, and because of the deep penetration and the simplicity of operation, it is easier to make good welds in less time with the HANSEN. The same features of design which make this possible also account for the HANSEN'S remarkable electrical efficiency.

NORTHWESTERN MFG. CO.
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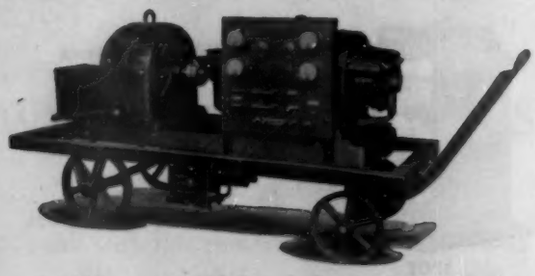

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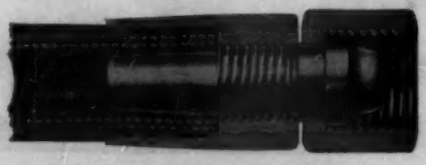

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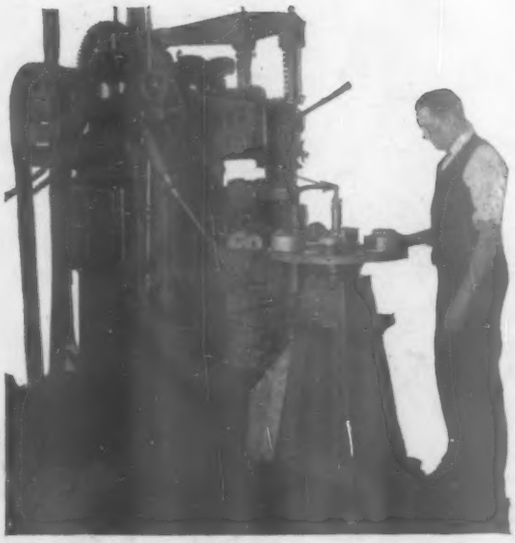

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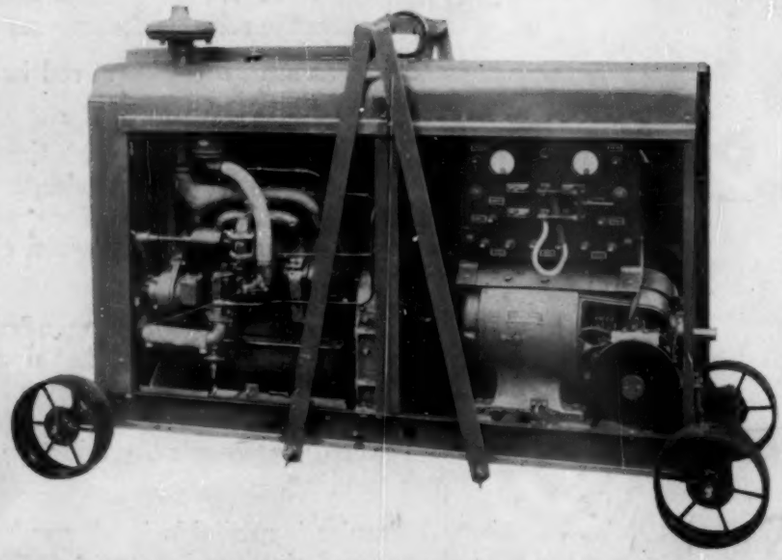

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